ESSAYS ON NON-MARKET VALUATION OF ENVIRONMENTAL RESOURCES: POLICY AND TECHNICAL EXPLORATIONS

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To my late father Constantinos Kontoleon

ABSTRACT

This thesis consists of a portfolio of research papers examining key contemporary technical, methodological and policy issues on the use of non-market valuation in environmental decision-making. The introductory chapter provides a short discussion of the structure and general aims of the thesis. The rest of the thesis is divided into two parts. Part A (consisting of Chapters 2, 3, and 4) contributes to the literature on the analysis and design of the two most commonly used stated preference methods, Contingent Valuation (CV) and Choice Modelling (CM). Chapter 2 examines the impacts of using alternative opt-out formats in CM studies, Chapter 3 presents a latent segmentation model as an alternative means of accounting for preference heterogeneity in discrete choice random utility models, while Chapter 4 introduces a generalised limited dependent variable modelling approach to account for non-trivial number of zero responses in open-ended-type willingness to pay CV data. Part B (consisting of Chapters 5 and 6) contributes to the literature on the role of stated preferences in environmental policy and legal decision-making. Chapter 5 uses the CV method to examine the nature of wildlife values in the face of the ongoing policy debate between *ex situ* and *in situ* conservation. Lastly Chapter 6 seeks to assess the US experience with using non-market valuation in courts with the aim of providing suggestions as European legislators formulate the direction of the new EU environmental liability regime.

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CHAPTER ONE

Overview of Thesis

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Overview of Thesis

1.1. Prolegomena

This thesis consists of a portfolio of research papers examining key contemporary technical, methodological, policy and legal issues on the use of non-market valuation in environmental decision-making.

Economists have been devising methods for measuring preferences for non-market goods or externalities since the 1840's when Jules Dupuit attempted to assess the benefits of new roads and bridges in France. Over the last fifty years such tools have been developed and used (to varying degrees) in all facets of environmental decision-making including project appraisal, legislative reviews, assessment of damages, modification of national accounts, or simply to demonstrate that an environmental issue is important in economics terms (Carson *et al.* 2002). Non-market valuation tools are traditionally classified into revealed and stated preference methods. The former examine actual behavioural or choice data from 'surrogate' markets associated with an environmental good in order to indirectly infer the intensity of individual preferences (or simply individual 'values') for that good. The latter, use surveys to construct a hypothetical market for the provision of an environmental public good through which respondents can directly reveal their preferences. Econometric tools are then used to infer values for the change in the level of the provision of the good. The focus of this thesis is on stated preference methods. Each of the chapters provides a self-contained research output, including its own detailed literature review. To avoid repetition this introductory chapter provides a short discussion of the structure and general aims of the thesis as well as an overview of the chapters themselves.

1.2. Structure and aims of thesis

The thesis is divided into two parts. Part A consist of Chapters 2, 3, and 4 and aims at contributing to the literature on the analysis and design of the two most commonly used stated preference methods, Contingent Valuation (CV) and Choice Modelling (CM). These chapters are, thus, fundamentally technical in nature. Chapter 2 examines the impacts of using alternative opt-out formats in CM studies, Chapter 3 presents a latent segmentation model as an alternative means of accounting for preference heterogeneity in discrete choice random utility models, while Chapter 4 introduces a generalised limited dependent variable modelling approach to account for non-trivial number of zero responses in open-ended-type willingness to pay CV data. Part B consists of Chapters 5 and 6 and aims at contributing to the literature on the role of stated preference studies in biodiversity conservation and in damage assessment. Hence, the second part is primarily policy oriented. Chapter 5 uses the CV method to examine the nature of wildlife values in the face of the ongoing policy debate between *ex situ* and *in situ* conservation. Lastly Chapter 6 seeks to assess the US experience with using non-market valuation in courts with the aim of providing suggestions as European legislators formulate the direction of the EU environmental liability regime.

All these topics belong to the extensive set of 'anomalies' that are still currently under investigation in the 'research paradigm' of 'environmental valuation'. The selection of the specific topics from this vast set was motivated by my studies in micro-econometrics at the Department of Economics at UCL as well as from the numerous valuation projects I was associated with under my capacity as research fellow at CSERGE-UCL. Comprehensive coverage of other contemporary issues on the design, analysis and application of stated preference tools are provided by Bateman *et al.* (2003), Haab and McConnell (2002), Bateman and Willis (2000), and Louviere *et al.* (2000). A through review of conceptual, philosophical and legal issues not discussed in this thesis can be found in Bromley and Paavolva (2002), and Kontoleon, Macrory, and Swanson (2002).

Lastly, the thesis hopefully exhibits the epistemological stance taken during the course of this research. This consisted of maintaining an *interdisciplinary* outlook that considered not just welfare theory and econometric aspects of stated preference methods but also utilised relevant literatures from experimental psychology, psychometrics, philosophy and law.

1.3. Summary of individual chapters

The first part of the thesis is preoccupied with technical and methodological issues on the analysis and design of contingent valuation and choice modelling approaches. An important aspect of the design of stated preference choice experiments concerns the inclusion and format of an opt-out option in the hypothetical choice set(s) presented to the respondent (Adamowicz and Boxall 2001). Chapter 2 assessed the implications from using alternative 'opt-out' formats in choice experiment studies. Two alternative opt-out formats have been widely used, the 'do not buy' format and the 'buy/choose my current brand' format. The decision of which format to use in different cases may have a substantial impact on the estimated parameters and welfare measures derived from choice experiment data (e.g. Banzhaf *et al.*, 2001; Olsen and Swait, 1998). These impacts are examined in a data set from a choice experiment study on consumer resistance to genetically modified content in foods. A split sample design was used in which the first treatment was provided with the option of 'not buying' the good at all while the second with an option of 'buying their usual brand'. Information over the actual purchasing habits of this latter group was collected and was incorporated into the estimation processes. The results from each treatment were separately analysed and the impact of alternative opt-out formats on response patterns and on the significance and stability of coefficients across treatment groups was examined. In addition, using findings from experimental psychology literature (e.g. Huber and Pinnell, 1994a; Dhar and Simonson, 2001) the possible behavioural and psychological forces that are at work under each treatment were assessed. Finally, certain methodological implications for the design of choice experiment studies are drawn.

Accounting for preference heterogeneity in random utility models enhances both the unbiasness of the estimated coefficients and the policy usefulness of the results (Layton 2000, Train 1998). The second chapter presents an application of the latent segmentation model for accounting for preference heterogeneity in a data set obtained from a stated preference choice experiment study on the value of reducing the genetically modified content in the production of one commonly consumed food, namely eggs. The model is based on the behavioural framework of McFadden (1986a) that allows for constructing an econometric model that *simultaneously* estimates segment membership and choice. The model also utilises latent constructs as direct determinants of segment membership and indirect determinants of product choice as prescribed by Ben-Akiva *et al.* (1997). These latent characteristics are introduced *via* proxy indicator variables derived using psychometric techniques. The analysis shows that the latent market segmentation model not only accounts for preference heterogeneity across individuals, but at the same time identifies segments of consumers that are characterised by common demographic and psychographic traits. This modelling approach is then compared to other more commonly used means of accounting for preference heterogeneity, the interaction effects, covariance heterogeneity and random parameters models, and is shown to outperform all alternative specifications on both econometric and policy relevance grounds. Lastly, implications for future research in latent segment modelling approaches are explored.

Contingent valuation open-ended-type data are prone to contain large proportions of WTP zero observations. Chapter 3 utilises the work of Blundell and Meghir (1987) to develop a generalised limited dependent variable modelling approach for the appropriate analysis of such data. This approach involves estimating a series of interrelated models that account for zeros in different ways and imply different data generating processes. Then, and after testing and accounting for heteroscedasticity and non-normality, nested and non-nested tests between competing models would suggest the most suitable specification for each case. This econometric approach may be more permissive and less arbitrary than other commonly used practices in dealing with zero WTP observations in that it does not exclude any observations (such as 'protest') and it does not impose any *a priori* behavioural restrictions. The approach allows for flexible parameterisation and distributional assumptions so that qualitatively different types of zero responses (such as abstentions, corner solutions and protests) can be accounted for. Also, the behavioural framework of discrete random preference regimes developed by Pudney (1989) is used as a basis for examining the determinants of the participation and payment decisions. This generalised modelling approach is applied to payment card WTP data obtained from a contingent valuation study that sought to estimate values associated with the conservation of the Giant Panda. The Inverse Hyperbolic Sine double hurdle dependent model (Yen and Jones 1997) was found to outperform all other nested specifications while the parameterisation of the variance was found to be necessary to account for heteroskedasticity. The assumption of independence between the participation (or reporting) and payment decision was rejected. Finally, the implications for the design and analysis of open-ended-type contingent valuation studies are highlighted.

The second part of the thesis moves away from exploring contemporary technical and methodological aspects of stated preference valuation methods to investigate policy and legal issues concerning the use of these techniques in environmental decision-making. Chapter 5 presents the results from a contingent valuation study that examined the magnitude and nature of values for the conservation of one highly celebrated species, the Giant Panda. The study was motivated from observing a paradox in some of the policies undertaken by numerous organisations engaged in wildlife and biodiversity conservation. On the one hand we can observe the predominance of the flagship species phenomenon as a means for raising support for general biodiversity conservation and on the other we can discern an increasing reliance on *ex situ* wildlife conservation policies that do *not* contribute to habitat conservation. First, can a particular high profile endangered species such as the Giant Panda generate funding for the conservation of its own habitat? This is an important policy question considering that we observe a clear shift towards *ex situ* Panda conservation polices while the funds that are being utilised for this purpose stem from existence values (e.g. wildlife donations). The study finds, first, that there is clear WTP for acquiring the property rights for panda habitat. The nature of this demand is found both convincing and logically coherent in that it is an increasing function of land (at a diminishing rate). Second, what is the *nature* this value for panda habitat? This was explored by decomposing the elicited values into genetic stock, animal welfare and implicit biodiversity values. The results show that the latter type of value consist of almost half of total value implying that the Panda is in fact a potential instrument for greater biodiversity conservation. Thirdly, the study shows that these implicit biodiversity values are dependent on the preservation of the flagship species itself, implying that the panda is not only a potential instrument for habitat conservation, but a necessary one. Finally, we discuss the implications of the study for the *ex situ* vs. *in situ* conservation debate as well as the extent to which the flagship approach is capable of contributing to wider biodiversity conservation.

The final chapter explores the use of valuation in courts for setting the level of compensation for environmental damages. Legislators in the European Union are currently formulating the direction of the new EU environmental liability regime. The provision in the recently published EU Environmental Liability Directive are likely to pave the way for the use of economic valuation tools in European courts. The concluding chapter seeks to assess the US experience with using CBA in courts with the aim of providing suggestions as European legislators formulate the direction of the EU environmental liability regime. The US experience highlights the issues that are likely to be important in the future in the EU. These are identified as: i) issues of accuracy of valuation studies; ii) the cost of valuation studies iii) the issues of consistency of valuation with the compensatory objective of a liability regime; and v) issues of standing and aggregation regarding non-use values. These topics have been the basis for ongoing debate in the US and are discussed with the aim of providing some ideas for consideration in light of the development of the EU environmental liability regime. The concluding discussion summarises the issues and provides recommendations for future research on the application of valuation for assessing damages.

PART A: TECHNICAL AND METHODOLOGICAL EXPLORATIONS

CHAPTER TWO

Assessing the Impacts of Alternative 'Opt-out' Formats in Choice Experiment Studies

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Assessing the Impacts of Alternative 'Opt-out' Formats in Choice Experiment Studies

2.1. Introduction

A key methodological issue in the design of choice experiment studies concerns the decisions of whether and in what format should an 'opt-out' alternative be included in the experimental design (Adamowicz and Boxall, 2001; Carson, *et al.* 1994). The opt-out alternative is in essence an option that competes with the other alternatives in the choice set. In demand choice experiment (CE) applications, it is usually framed either as a 'no purchase' option or in terms of choosing an 'alternative option' or one's 'customary or favourite brand' (Tversky and Shafir, 1992; Dhar, 1997).[1] The use of an opt-out alternative has been recommended by recent state-of-the-art CE design guidelines (e.g. Bateman *et al.,* forthcoming 2003; Adamowicz and Boxall, 2001; Bennett and Blamey, 2001; Louviere *et al.,* 2000). The arguments behind this recommendation include increasing the realism of the exercise (Batsell and Louviere, 1991; Carson *et al.,* 1994), enhancing the theoretical validity of the welfare estimates (Bateman *et al.,* 2003; Adamowicz and Boxall, 2001) and improving the statistical efficiency of the estimated choice parameters (Louviere *et al.,* 2000; Anderson and Wiley, 1992). As a result, an increasing number of marketing and non-market valuation CE studies are incorporating an opt-out alternative in their experimental design. However, little attention has been given to the effects on choice experiment responses from the use of *alternative* opt-out formats. Yet, it is likely that the format of the opt-out alternative presented to respondents may impact on how they perceive the choice task. This in turn may have a considerable impact on the resulting choice shares as well as on attribute weights of the estimated multinomial choice model. It has been acknowledged, however, that the decision over *which* opt-out format to use under different situations is not an easy task (Adamowicz and Boxall, 2001;

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[1] In other cases (such as 'sate of the world' studies) the opt-out alternative can consist of a regular profile whose attribute levels are held constant over all choice sets (such as a baseline or status quo scenario).

Carson *et al.,* 1994). The aim of this chapter, therefore, is to contribute to this discussion by assessing the impacts of alternative 'opt-out' formats in choice experiment studies.[2]

This issue is examined in a choice experiment study that sought to ascertain the preferences of the UK public over alternative brands of one commonly consumed food, namely eggs. The aim was to investigate whether decision-making processes over alternative egg brands are invariant with respect to the format of the opt-out alternative provided to the respondent. A split sample design was used in which two groups of respondents were provided with a choice experiment questionnaire that differed only with respect to the opt-out alternative used in the choice sets. The first treatment received a questionnaire that included a 'no-purchase' opt-out alternative while the second a 'buy-my own brand' alternative. In the latter case revealed preference information of one's customary brand was also collected and incorporated into the estimation process. The results from each treatment were separately analysed and the impact of alternative opt-out formats on response patterns and on the significance and stability of coefficients across treatment groups was examined. In addition the possible behavioural and psychological forces that are at work under each treatment were assessed. Finally, certain methodological implications for the design of CE studies are drawn.

2.2. Opt-out alternatives and choice experiment studies: advantages and complications

The main argument for the inclusion of an opt-out alternative in CE studies has been that of realism enhancement and avoidance of a forced choice (e.g. Batsell and Louviere, 1991). Refusing, avoiding or delaying choice as well as choosing an alternative option or brand to those offered is an integral parts of almost all every day market transactions.[3] Normative theories of rational choice have incorporated the decision 'not to choose' as simply another option in the individual's choice set (e.g. Huber and Pinnell, 1994a). For example, in the random utility framework the probability of observing an opt-out response

[2] This chapter focuses on the impact of alternative opt-out formats on choice experiments studies. The implications for contingent ranking, contingent rating, and paired comparisons studies are beyond the aims of this chapter but consist an important direction for future research.

[3] For example, Adamowicz *et al.* (1998) make the point that "one should design stated choice experiments to allow one to observe and model non-choice because its such an obvious element of real market behaviour"

would be inversely related to the quality of the choice set.[4] That is, an individual would opt-out if the quality level of the options in the choice set did not surpass a subjective threshold (reservation) utility level.

The immediate implication of disallowing the possibility of choice deferral is that this may induce individuals to make forced and biased choices. Several studies from the experimental psychology and marketing literatures have shown that respondents faced with a forced choice tend to choose certain options in the choice set on the basis of simplifying and compromising heuristics that mask 'true' individual preference revelation (e.g. Dhar and Simonson, 2001; Dhar, 1997; Huber and Pinnell, 1994a; 1994b; Olsen and Swait, 1998; Tversky and Shafir, 1992). These biases could lead to an overstatement of the likelihood that the individual would actually choose one of the hypothetical alternatives if choosing to purchase nothing or an alternative brand is preferred over the hypothetical alternatives as well as to bias the estimates of the importance of the relevant weights of the choice attributes (Banzhaf *et al.,* 2001).[5]

In cases where the analyst is examining demand behaviour (such as recreational site choice, market purchases of alternative product brands etc.) the inclusion of some "opt-out" option in the choice set is *necessary* if the estimated welfare measures results are to be consistent with demand theory. This is so because demand effects (non-purchase options) can *only* be identified if the possibility of opting out is provided (Bateman *et al.,* forthcoming 2003; Adamowicz and Boxall, 2001, Bennett and Blamey, 2001; Batsell and Louviere, 1991). Hence, not incorporating a default or no choice alternative in a CE renders the resulting estimated models inconsistent with demand theory and makes interpretation of welfare measures such as willingness to pay (WTP) difficult.[6,7]

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[4] For example, the multinomial logit model (which offers merely a convenient avenue to operationalise the random utility model) defines the probability of choosing the default as:

$$\Pr(default) = U_D \Big/ (U_D + \sum_{k=1} U_k)$$

A subtle characteristic of this model is that it accounts for the quality of the choice set through the magnitude of the utility scores (the U_K's). Hence, as choice set quality increases, the probability of choosing the default decreases. This property has been explicitly explored in a study by Huber and Pinnell (1994a) who find that one is more likely to make a choice (and not go for the opt-out alternative) from a more attractive choice set and argue that this is consistent with most normative models of default choice.

[5] Put differently, in the absence of the opt-out alternative a nonzero value is implied in the estimated likelihood function for people who would not choose one of the alternatives.

[6] At best, WTP measures from such studies are conditional on making a choice, which begs the question of how to identify choosers in the first place (Bennett and Blamey, 2001, p. 26). However, if such identification of choosers and non-choosers were *a priori* possible, the very reason for conducting a choice experiment

Finally, there are other practical advantages of including an opt-out alternative in the choice sets of CE studies such as aggregating data sets that use the same opt-out alternative (e.g. Haab and MaConnell, 2002; Louviere and Woodworth, 1983) as well as enhancing the efficiency of the experimental choice set design (e.g. Haaijer *et al.*, 2001; Louviere *et al.*, 2000; Anderson and Wiley, 1992).[8]

The introduction of an opt-out alternative, however, may also generate complications in the analysis of CE data sets. These concern both various behavioural implications as well various econometric challenges that emerge from the inclusion of such an alternative.

Regarding the former, the opt-out option may distort the incentives for 'true' preference revelation as predicted by rational choice theory. The main source of distortion is that it provides an 'easy way out' to respondents faced with a "difficult" choice situation (Carson, Groves and Machina, 1999; Olsen and Swait 1998; Huber and Pinnell, 1994a; Dhar and Simonson, 2001; Luce, 1998). This is corroborated by numerous experimental psychology

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would be in doubt. Hence, any meaningful demand analysis that employs the CE approach must include an opt-out alternative. The interpretation of this alternative in applied work is that of an efficient proxy for the likelihood that the respondent will leave the market (Olsen and Swait, 1998). This will allow for the estimated discrete choice model to reflect not only shifts in market share due to differences among alternatives, but also to be responsive to shifts in *total* demand due to the general quality of these alternatives (Huber and Pinnell, 1994a, p. 4).

[7] Similar reasons for including an opt-out alternative also hold for cases dealing with "state of the world choices" or choice experiments that offer respondents alternative policy options. In these cases the opt-out option may be a status quo or some baseline scenario. For example, Bateman *et al.* (forthcoming 2003) make the point that "it is necessary to include a status quo option in the choice set in order to achieve welfare measures that are consistent with demand theory. This is, because, if a status quo alternative is not included in the choice set, respondents are effectively being 'forced' to choose one of the alternatives presented, which they may not desire at all. If for some respondents the most preferred option is the current baseline situation, then any model based on a design in which the baseline is not present will yield inaccurate estimates of consumer welfare." In general, the effect of the absence of the baseline alternative on the estimation of Hicksian surplus is to bias the estimates upward (Boyle *et al.*, 2001). Further, Adamowicz and Boxall (2001) stress that in cases involving "state of the world choices" the context of the choice may be very important. If the choice context is a referendum (choose from alternative policies) then respondents may expect that the opportunity to make no changes should be available. If a policy change is inevitable, then the inclusion of an opt-out alternative is not necessary. Note that there have been concerns over the possibility of 'status quo bias' as the result of including a default alternative. (e.g. Bennet and Blamey, 2001). However, Adamowicz and Boxall (2001) point out that if such behaviour is to be expected in real referendum situations, then the analyst should provide the opt-out options in hypothetical referenda. The biases that may occur with the inclusion of a status quo alternative in 'state of the world' studies are discussed in Bennett and Blamey (2001). The remaining of this chapter focuses on examining the effects of opt-out alternatives in market (demand) choices and not 'state of the world' choices. Hence, the discussion is more relevant for recreation studies as well studies concerning areas such as food safety and health. More, generally, it is relevant for any choice situation that involves the possibility that a choice can be deferred, delayed or that one can decide to choose their customary/regular brand or option.

[8] See Huber and Pinnell (1994), Banzhaf *et al.* (2001) and Olsen and Swait (1998) for a more thorough discussion of these points.

studies that have questioned the conviction of many normative choice theories (such as random utility theory) that the decision to opt-out is a reaction to poor choice-set quality or attractiveness. Instead they have interpreted opting out as means of coping with decision difficulty. The implication from this body of work is that when faced with a difficult choice, individuals may be induced to employ decision-making processes that may invalidate or bias the predictions of the normative choice models.[9]

Early psychological work has analysed choice difficulty and conflict as the result of lack of respondent "experience" or "confidence" as well as "trade-off difficulty" (e.g. Berlyne, 1960; Tyebjee, 1979; Janis and Mann, 1977; Shepard, 1964; Kiesler, 1966). Other studies have argued that individuals prefer consequences that arise of inaction over those arising from action since the decision to stay within a status quo has certain psychological advantages (e.g. Haaijen, 1999; Baron and Ritov, 1994; Ritov and Baron, 1990). Moreover, other theories have viewed choice difficulty and conflict as stemming from low "affective differences" within the choice set. These theories predict that the individual will choose to opt-out if a threshold level of within set 'heterogeneity' is not available (e.g. Bockenholt *et al.,* 1991; Busemeyer and Rapoport, 1988).[10] In fact, the majority of the experimental psychology literature works on this premise, namely that individuals tend to choose the opt-out alternative when faced with a choice set that contains relatively homogeneous options (e.g. Huber and Pinnell, 1994a, Tversky, Sattath and Slovic, 1988, Dhar and Glazer, 1996; Shafir, 1993). Choice set homogeneity would increases decision

[9] Many economists that have recommended the use of the opt-out alternative have acknowledged this danger and recommend that appropriate design efforts should be employed to reduce such a bias. For example, Olsen and Swait (1998) point out that "... one of the concerns with the inclusion of the no-purchase alternative in a choice task is that respondents may use it as an "easy way out" in a difficult or long task. In years of using the [no-purchase alternative] (as well as other fixed alternatives) in academic and other studies, however, we have yet to see strong evidence of such behaviour. Nonetheless, the possibility of this calls for care in task design, instrument pretesting, careful respondent recruitment and respondent motivation (through task relevance, as well as financial incentives). These same cares are called for anyway so as to enhance or preserve data quality, so no real additional work is called for." Though we agree with the call for the need to follow appropriate design guidelines to minimise a systematic bias for the opt-out alternative the danger from status quo or opt-out bias still remains. Yet, if this behaviour is to be expected in the real world then the opt-out alternative should be included irrespective of its consequences (Adamowicz and Boxall, 2001, p.21). There is due cause for alarm, however, when the opt out bias is the product of the design of the study. Hence, I would add to the prescription of Olsen and Swait (1998) that opt-out can be minimized by obtaining a better understanding of the impacts from introducing an opt-out alternative in the choice set provided by the experimental psychology literature. This point highlights the need for the valuation literature to attain a multidisciplinary orientation.

[10] A choice set is characterised by 'heterogeneity' when its attributes and levels are not sufficiently distinguishable by respondents.

difficulty and conflict leading to a higher tendency to defer choice.[11] The motives for opting out under decision difficulty have been explained in terms a 'cost' that the individual is willing to accept in return for continuing the search for more (and better) alternatives or for more information as well as a means for reducing the risk of making a 'wrong' decision (see Huber and Pinnell, 1994a).

Along these lines, Dhar (1997) has shown that adding an attractive alternative to an already attractive choice set increases the preference of the no-choice option. This finding has been generalised to more complex choice sets involving more dimensions and more choice alternatives in field studies (e.g. Huber and Pinnell, 1994a) controlled laboratory studies (e.g. Tversky and Shaffir, 1992) as well in studies involving real decisions and pay-offs (e.g. Dahr, 1997).

Regarding the *types* of options that individual select when encountered with a difficult choice *and* are forced to choose (i.e. when opt-out is not available) these have been found to be (a) base-line options that represent 'average', generic or 'compromise' options (e.g. Simonson, 1989), (b) asymmetrically dominating alternatives (i.e. alternatives that have one dominating dimension) (e.g. Montgomery, 1989; Tversky, Sattath, and Slovic, 1988; Slovic, 1975)[12] and (c) high quality high price alternatives (e.g. Simonson, 1992; Simonson and Tversky, 1992). In all cases, experimental psychologists contend that the individual selects such alternatives since they are easier to justify, less susceptible to criticism and are associated with a lower likelihood of error and regret.

Recently Dhar and Simonson (2001) have confirmed these findings using a series of laboratory experiments involving real pay-offs. The authors present a series of empirical evidence that question the implicit assumption made in the choice experiment literature that the inclusion of a no-choice option only draws proportionately from the various available alternatives, such that the qualitative conclusions are unaffected. They show that the no-choice option directly competes with alternatives that individuals tend to select when they are faced with a difficult choice and forced to choose. The implication of these findings is that compromise, asymmetrically dominating and high quality/price options are

[11] This general finding is also predicted by the experimental psychologists that view choice as a constructive process (e.g. Tversky, Sattath and Slovic, 1988; Payne, Bettman and Johnson, 1992 and 1988, Slovic, 1995) as well as others that have stressed the importance of "justification" in choice (Tetlock, 1985, Newell and Simon, 1972).

most vulnerable to competition from the no-choice option. Conversely, they show that options that appear to be selected because of the decision maker's underlying preferences are affected to a much lesser degree by the introduction of the no-choice option.[13]

In addition to these behavioural implications, the use of opt-out alternative also bears certain econometric challenges. First, in many cases the no-choice alternative provides no information about the individual's relative preferences for attributes of the hypothetical alternatives – one of the main aims for undertaking a choice experiment in the first place. Secondly, the opt-out alternative may perplex the analysis of CE data since in many cases it is not apparent what attribute levels are associated with the opt-out option. For example, in many recreation studies it is not clear what respondents are selecting when they do not choose any of the offered recreation packages (choose another package, choose a substitute good etc). One way around this difficulty is to construct and include a fixed alternative with non-zero attribute levels that serves as a baseline option. Though, the inclusion of such an option may enhance the efficiency of the experimental design (Louviere *et al.* 2000) it does not avoid the issue of inducing a forced choice since the individual may still prefer his/her current brand over the alternatives offered in the choice set (Banzhaf *et al.*, 2001).

Thirdly, an implicit assumption in the choice experiment studies is that the opt-out choice would take share proportionately from the various available alternatives, consistent with the assumption of independence of irrelevant alternatives (IIA). This implies that the qualitative conclusions in understanding the tradeoffs consumers make among options

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[12] This would be consistent with lexicographic preferences.

[13] Though the aforementioned experimental work has established that the opt-out option does affect individual behaviour in experimental/hypothetical settings (in both desirable and non undesirable directions) it has not investigated how these findings impact on the parameters of a preference model obtained from a standard conjoint or experimental choice study. A recent study by Olsen and Swait (1998) has examined this issue using a split sample CE setting on the consumption of alternative orange juice brands. Each treatment received the same choice set design but differed only in the presence/absence of the opt-out alternative. The authors find that the absence of the opt-out alternative leads to significantly different coefficients, compared to those obtained when the alternative is present. This implies that the probability of choice is *not* independent of the presence of the opt-out alternative, which is a commonly made assumption in academic and commercial research. Also, they find that in aggregate, consumers seem to exhibit more nonlinearities in preferences (reflecting application of conjunctive decision rules, or other heuristics) when the opt-out option is present, compared to that option being absent. Furthermore, their work suggests that depending upon the types of decision rules used by consumers when the opt-out is absent, important attributes can either become inflated (if they lend greater importance to primary conjunctive attributes) or deflated (due to the use of attributes other than primary conjunctive ones to resolve preference ambiguities) compared to the opt-out present case. This deflation or inflation may have a consequent impact on attributes of secondary importance, by respectively, inflating or deflating them. (Olsen and Swait,1998).

should be (according to the IIA property) unaffected from the inclusion or not of the opt-out alternative. However, the IIA assumption tends to be violated when the opt-out alternative is introduced since it tends to take away greater share from certain options rather than others that individual tend to select under forced choice (Dahr and Simonson, 2001). This is so because the reasons to choose the no-choice option may differ from those governing the choice of any of the other profiles in a choice experiment and hence the "no-choice" option cannot be seen as just another choice alternative, leading to potential violations of IIA (Haaijen, 1999). The violation of the IIA assumption implies that any experimental findings may be systematically biased and lead to incorrect predictions about relative shares and attribute weights when consumers have the option not to choose. This poses added econometric challenges to the researcher of detecting and solving possible IIA violations. This would necessitate the use of an alternative econometric model such as the random parameter logit.

Finally, some have pointed out that the opt-out alternative may not be desirable and should not be used in certain cases. Dhar and Simonson (2001) point out under certain conditions if consumers believe that choice must be made sooner or later or that procrastination is damaging, they might prefer not to have the no-choice option.[14] In practice, CE practitioners have justified the decision not to include an opt-out alternative along these lines. For example, Blamey *et al.* (2001) in a study on environmental friendly toilet paper claim that the exclusion of the no-choice option would introduce only a small bias in market share estimates . They argue that this bias is worth accepting in order to avoid the potentially greater 'easy way out' bias that may arise if the opt-out alternative is offered. Implicit in the reasoning utilised by such studies is that the opt-out alternative is framed in terms of "no-purchase". However, the opt-out option can be framed in terms of 'choose an alternative brand' and this would retain the theoretical validity of the study as well as the realism of the exercise. The realities of choice are such that the individual has the discretionary ability to avoid or delay choice or purchase a substitute good. Hence, allowing respondents that participate in CE studies the possibility of opting out appears to be warranted in virtually all cases. The following section argues that whilst the decision to include the opt-out alternative seems relatively unambiguous, that over *which* opt-out format to employ is neither innocuous nor easy to determine.

[14] Furthermore, some psychological parameters such as the need for "closure" (e.g. Webster and Kruglanski, 1994), may necessitate the absence of an opt-out alternative.

2.3. Choosing between alternative opt-out formats

The general conclusion from the preceding discussion is that despite the potential distortions and complications from using the opt-out alternative it should be routinely included in CE designs (under some format) since it enhances both the realism of the experiment and the statistical robustness of the estimated results (Olsen and Swait, 1998).[15] The most commonly used opt-out formats are "I would not choose any of theses alternatives" and "I would choose my favourite /customary brand"? However, leading CE practitioners have come to acknowledge that "the form of the opt-out alternative is not easy to identify" (Adamowicz and Boxall, 2001).

Several *a priori* recommendations as to which of these formats to use have been proposed. For example, Batsell and Louviere (1991) suggest that we use the format that most "closely approximates the choice setting experienced by individuals in real market conditions". Further, Carson *et al.* (1994) have suggested that the no-purchase option may be more useful in cases that seek to investigate market share, market penetration and participation. Alternatively the 'own brand' format may be more suitable for situations that seek to investigate which attributes or what levels of attributes a new product or good must have in order to attract new consumers. (Carson *et al.* 1994). Finally, others have suggested (Dhar and Simonson, 2001; Blamey *et al.,* 2001) that the 'no-choice' format should not be used when the individual cannot realistically avoid making some choice. Prolonged holding out from choosing basic goods with no close substitutes, such as basic foods, may seem unrealistic.

Yet, such recommendations are quite vague and inconclusive while they have yet to be empirically examined. Determining which opt-out format closest approximates real market transaction is not always evident by virtue of the complexity of many everyday decisions. Further, research studies often involve overlapping goals and objectives (e.g.

[15] Note however that in practice many CE studies have not used an opt-out alternative. See Olsen and Swait (1998) for references of numerous consumer demand studies Boyle *et al.* (2001) for non-market valuation studies that have not used opt-out alternative. The number of these applications is surprising considering that not including such an option yields inaccurate estimates of consumer welfare that are not consistent with

studies may be interested in both determining market participation as well as the affective level of new attributes). Finally, choosing 'not to choose' is an integral part of almost all decisions, including decision over basic (inelastic) goods. For example, decisions over basic foods often include considerations over food safety levels that may induce individuals to hold-out for prolonged periods of time.[16]

The difficulty in choosing the format of the opt-out alternative is evident in the marketing literature where both the no purchase and the own brand format have been used but no evident and consistent pattern of which format is more suitable under different situations is discernable.[17] The situation is even less clear in the non-market valuation literature where CE practitioners have almost exclusively used the 'no-choice' opt-out option even in cases where the 'choose an alternative brand' would seemed more reasonable.[18] A tacit assumption made in these studies is that the individual's decision-making process is invariant with respect to the opt-out format offered to the respondent. A corollary of this assumption is that the probability of choosing a particular option (or its choice share) is probabilistically independent of the opt-out format faced by the decision maker. Although this is an empirical issue, CE analysis have come to acknowledged that it is reasonable to expect that different opt-out alternatives would imply different behavioural implications and would be associated with different choice shares and attribute weights (e.g. Olsen and Swait, 1998, Adamowicz and Boxall, 2001).[19]

Despite these this claims, there is, however, a lack of comparative studies examining the effects from the use of alternative opt-out formats as well no attempts to corroborate the *a*

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demand theory! Moreover, when an opt-out alternative has been used in non-market valuation applications it has almost uniformly been of the no-choice format.

[16] Various food scare crisis are such as the BSE and GM food crises are examples in support of this point. Also, the food safety non-market valuation literature that has examined decision patterns over basic goods (e.g. Kuperis *et al.,* 1999; Henson, 1996; Van Ravensway and Hoehn, 1991) appears to adhere to this view and has included the opt-out option. A case for not including an opt-out option may be made in studies involving 'goods' that have no substitutes of any kind. Very few goods, however, would fit this description. Moreover, techniques that involve trade-offs should not generally be used for such goods in the first place (see last chapter) so the issue of whether to use an opt-out alternative in these cases is immaterial.

[17] For example, Louviere and Woodworth (1983), Huber and Pinnell (1994a and 1994b), Olsen and Swait (1998) have used the 'no-choice' format while Elrod *et al.* (1992) and Swait (1994) provide illustrations of the 'buy my usual brand' opt-out format.

[18] For example use no purchase format is used by Kuperis *et al.* (1999) in a study on individual preference for milk while Adamowicz *et al.* (1994) in a study on anger preferences over alternative fishing sites. In both cases the 'choose my usual brand/site' format may have been more realistic.

[19] In the case of public goods, choice of the opt-out alternative is interpretd as preference for the *status quo*. The way the *status quo* is framed may also have implications on the estimated welfare estimates.

priori recommendations mentioned above.[20] The only exception can be found in the work by Banzhaf *et al.*, (2001).[21] The authors use the choice modelling approach to investigate the effects of alternative opt-out options on the preferences of anglers over alternative fishing sites. The authors do in fact find that the choice of the opt-out format has serious implications for choice model parameter salience. Yet, contrary to their *a priori* expectations they find that the 'choose my usual fishing site' format outperformed (on both behavioural and statistical grounds) the 'choose neither site' option. This highlights the claim made about the vagueness of *a priori* recommendations over which opt-out format to use and the need for further research in this field. This is so, because the objectives of CE studies and the nature of the 'goods' being investigated are often multifaceted and thus it is by no means apparent which option is most appropriate to use. Hence, further empirical investigation on the impacts of alternative opt-out formats is warranted.[22] The next section describes the issues and hypotheses that will be explored while Section 2.5 presents the details of the experiment used to examine these hypotheses.

2.4. Assessing the impacts of alternative opt-out formats.

As explained above it is likely that alternative opt-out formats may have differential impacts on both relative choice shares as well as the estimated parameter results. This was attributed to the possibility that different opt-out formats may induce respondents to evaluate the choice sets in different ways (Banzhaf *et al.*, 2001). The possible differential impacts from alternative opt-out formats were explored in a CE case study. The overall purpose of the study was to explore the impact on individual purchasing decisions from introducing various levels of genetically modified content in one commonly consumed food, namely eggs. Most of the food studies from the marking literature (e.g. Olsen and Swait, 1998 on orange juice consumption) and *all* of the food-safety studies from the non-

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[20] This applies to all areas of economics where CE is used including studies on private goods as well on environment and health issues.

[21] The work of Banzhaf *et al.* (2001) was developed concurrently but independently from the research presented in this chapter. Our work differs from that of Banzhaf *et al.* (2000) in that (a) we explore the impact of different opt-out formats on the decisions over an everyday food product and not on a more elastic good such a recreation, (b) we examine the effects on the choice shares from the use of alternative opt-out formats and (c) explore the reasons *why* there are differences in parameter salience across opt-out treatments.

[22] The study developed here is akin to the body of CV literature that examined the impacts from allowing the option to defer in dichotomous choice CV studies as well as the studies that examined various framing issues with respect to eliciting WTP values (see Bateman and Willis (2000) for a review). It is only natural that the CE literature (being relatively a new method compared to CV) follows similar paths of methodological inquiry.

market valuation literature (e.g. Kuperis *et al.,* 1999 on chemicals in milk) have used the "no purchase" opt-out format. Yet, intuition suggests that such an opt-out format may bias the results of the study in that it may be interpretd by some respondents as an unrealistic forced choice. Confronted with such a choice situation the individual may be compelled to choose one of the hypothetical brands offered instead of going without the good. Yet, the individual may, in fact, have preferred another alternative brand (such as their customary brand) and hence the forced choices would lead to an overstating of the likelihood of selecting a particular brand with the hypothesised characteristics. Conversely, if individuals that choose not to purchase any of the hypothetical alternatives when in fact they preferred their customary brand, then the resulting CE data would underestimate the likelihood of consuming the good. An alternative format that has not been explored by the valuation literature and may avoid this bias is the "choose my own brand option". Since the determination of the most appropriate opt-out format has not been fully explored by the CE literature, both formats were examined in a split sample design. The study examined the possible impacts from alternative opt-out formats on choice shares as well as attribute weights. The study also tried to understand the nature of the differential impacts as well to try to assess which format would be most suitable for the specific case study. Finally, the study aimed at drawing some more general methodological conclusions for the use of the opt-out alternative in CE studies. More specifically, five possible differences that may emerge as the result of using one of these two opt-out formats will be explored.[23] The first hypothesis that is explored states that:

H_1: The relative share of the opt-out alternative is higher when this is framed in terms of choosing one's 'own brand' as opposed to the case where it is framed in terms of a 'no purchase' alternative.

Various possible explanations lie behind this proposition. As mentioned above, the frequently used 'no purchase' option may induce some respondents to respond as if faced with a forced choice. This may be the case when prolonged holding out is perceived as unattainable, pointless or undesirable.[24] This may lead individuals to select choices that they would not have chosen had they been provided with the option to select an alternative brand. Hence, the no purchase option may be systematically avoided and this may possibly

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23 Of course this list is by no means exhaustive and further research is warranted.

24 This may true for certain highly inelastic goods. Yet, it still remains to be seen if it also hold for other goods such as durables.

overstate the likelihood of certain of the other choices. Moreover, as mentioned in Section 2.2, introducing an inferior option into the choice set usually induces respondents to favour *not* to opt-out (e.g. Dhar and Simonson, 2001). To the degree that the no purchase alternative is seen as an undesirable alternative, its inclusion in the choice set would yield less opt-out decisions. Further, it was also stated in Section 2.2 that the inclusion of the opt-out alternative may provide an avenue for resolving difficult choices and induce people to opt-out (e.g. Huber and Pinnell, 1994a). One could reasonable expect that this effect may be more prevalent in cases where individuals are offered the chance to choose their 'own brand'. This could be argued on the basis of regret, risk aversion, 'default bias' as well as complacency to retain the status quo. Adamowicz and Boxall (2001) point out that to the degree that such effects are observed in the real world then there is little to be concerned. What is important to keep in mind, is that CE studies should include the opt-out format that best approximates real market transactions even if that induces relatively more choice deferral than an alternative opt-out format.[25]

Turning to the second hypothesis to be tested, it is important to examine whether the different shares of the opt-out alternative generated under the two alternative formats would *disproportionately* take from the shares of specific options in the choice set. Many CE studies imply that the use of any opt-out format would draw proportionately from all the other alternatives in the choice set. Yet, it may be the case that some opt-out formats induce respondents to systematically favour some alternatives over others. This implies that different opt-out formats may compete with some options more than they do with others. More specifically, the 'no purchase' format used in most CE studies may be perceived by some respondents as a form of forced choice. Section 2.2 described how decision making processes under forced choice has been found to be influenced by simplifying heuristics that tend to select options that are perceived as having the lowest likelihood of error or regret, are easy to justify (to themselves and others) or appear to be the best possible compromise. Such options include generic brand, asymmetrically dominating and high price and quality alternatives. Systemic favouring of these options may overstate their choice share as well as the salience of the attributes that characterise these options.

[25] Of course due design care must be taken so that the systematic preference for the opt-out is not an artefact of the study itself. Also, note that the recommendation for including the opt-out option that best resembles "real market transactions" also applies for public goods. In cases where the provision of the public good would be a novelty to respondents then the prefer

In contrast, the 'own brand' format may dampen the effects of such simplifying heuristics since individuals may feel free to select their usual brand if none of the alternatives in the choice set yield utility beyond their reservation level.[26] Further, extending the reasoning of Dhar of Simonson (2001) the choice share of the opt-out option under the 'own brand' format would take from the share of that alternative that may be associated with a lower level of criticism and regret but not with strong preference. In other words, the opt-out alternative under the 'own brand' format would compete more directly with options that are selected when individuals feel that they are forced to choose, as may be the case in the 'no purchase' format. These alternatives have been found to be high-price quality options, generic brand options as well as asymmetrically dominating options. The study presented in the next section included in the choice sets certain fixed (baseline) options that possessed these characteristics. The inclusion of such alternatives allowed the examination of the following hypothesis:

H_2: The relative share of a generic, asymmetrically dominating or high price-high quality option that is included as a fixed alternative in the choice set will be higher when the set includes a 'no purchase' opt-out alternative compared to when it includes the option of choosing one's 'own brand'.

The third hypothesis involves the effects of alternative opt-out formats on respondent fatigue. Typically, choice experiment studies present respondents with multiple choice sets and request that the individual provide a response in each case. This is necessary so that enough choice variability is attained which is required for estimating multinomial discrete choice models. The optimal number of choice sets presented to each individual varies depending on the complexity of the choice task, the conditions under which the experiment is conducted and the incentives provided to respondents. Any number between four and sixteen choice sets are usually used (Louviere *et al.*, 2000).[27] The phenomenon of respondent fatigue refers to cases where the individual's mental capacity (or simply patience!) may be exhausted after the first few rounds of choice sets. The phenomenon of fatigue is one of the main design issues that is still under great scrutiny (e.g. see Alpizar and Carlsson, 2001, Louviere *et al.*, 2000; Adamowicz and Boxall, 2001, and Bradley and

[26] This level refers to threshold level of utility that each choice in the set must yield in order to be preferred over the opt-out option.
[27] See the study of Hanley *et al* (2000) on recreational preferences over rock climbing alternatives for a test of the optimal number of choice occasions to present to each respondent.

Daly, 1994). Respondent fatigue could result in various 'atypical' response patterns. For example, fatigue may be manifested as an enhanced occurrence of the default opt-out option after a few rounds. It is plausible that the degree of respondent fatigue may differ across alternative opt-out formats. The direction of this difference is not clear *a priori* and hence we will investigate the two-way hypothesis that:

H_3: Respondent fatigue rates differ across choice set designs that use alternative opt-out formats.

The fourth hypothesis concerns differences in choice model parameter salience as the result from using alternative opt-out formats. As mentioned above, it is likely that the two opt-out formats may induce individuals to evaluate the chose sets differently (Banzhaf *et al.*, 2001). For example, the no-purchase format may be perceived as entailing a forced choice. It is, thus, reasonable to expect that under forced choice the individual may utilise a different decision making rule than would be used under free choice or when they could choose their 'own brand'.[28] Regardless of the exact decision mechanisms followed under each condition, changes in decision rules should induce different weights for one or more attributes (Olsen and Swait, 1998). Hence, we should expect a change in the estimated attribute weights between conditions in which the opt-out alternative is framed as a no-purchase option and cases in which it is posed in terms of an 'own brand' choice. This in turn, entails that the estimated part-worths (which are the ratio of two attribute weights) will be affected by the format of the opt-out alternative.[29] The hypothesis to be tested is thus:

H_4: Attribute weights will differ across choice settings that use alternative opt-out formats.

Olsen and Swait (1998, p.3-4) provide some guidance as to the nature of the differences in attribute weights. Research from consumer behaviour and experimental psychology literatures has been providing increasing evidence that individuals resort to cost or effort minimising decision making processes as a means of overcoming their limited information

[28] Bettman, Johnson and Payne (1991) provide a discussion of alternative decision making rules under various choice circumstances and settings.

[29] Note that whilst there are no *a priori* predictions regarding the relative importance of specific attribute weights (i.e. marginal WTP values) under alternative opt-out formats, we can generally expect that the WTP value for the product *profiles* as a whole would tend to be lower under a choose my own brand option. This follows from the expectations that the 'no purchase' option would induce less opting out and thus yield higher WTP values for the hypothetical profiles. Recent support to this claim is provided in Boyle *et al.*

processing capabilities (Bettman, Johnson, Payne, 1991 and Bettman *et al.,* 1998). Individuals seem to be trading off between the costs (in terms of mental effort) of reaching a decision and the accuracy of the decision reached. A "good" decisions is reached without expending inordinate amounts of mental and other resources in the process (Shugan, 1980, Karni and Schawrz, 1977; Stigler, 1961). Based on this reasoning it can be argued that individuals that are faced with the more restrictive choice setting that includes a no-purchase alternative will tend to adopt simpler heuristics than they would under a 'choose their own brand' setting. For example, individuals faced with a forced choice may choose a decision protocol that minimizes the likelihood of error or regret. It is reasonable to expect that individuals will more easily avoid expending greater effort if their goal changes from selecting the "best" alternative (when the option to choose their own brand is available), to minimizing the consequences of having to choose among alternatives that might all be inferior (when faced with the restrictive no-purchase opt-out format). To the extent that this is true (i.e. decision makers try to reduce the "costs" of having to choose unacceptable options and therefore appeal to simplified secondary choice rules when faced with a forced choice), it is likely that preference models will indicate the existence of *fewer* non-linear relationships compared to when the 'own brand' option is available (Olsen and Swait, 1998).[30] Such non-linear relationships or conjunctive decision making processes will be captured by significant attribute interactions terms. Hence, the final hypothesis that we will be testing is:

H_5: A choice set design using the 'no purchase' opt-out format would identify less interaction effects than one using the 'buy my own brand' format.

2.5. Experimental design and survey development

These hypotheses were examined in a CE case study investigated the preferences of UK consumers over alternative egg brands or profiles. Although the particular good is frequently consumed by most UK households, the specificities of the study suggested that including an opt-out alternative is warranted. More specifically, the overall objective of

(2001). The current chapter focuses on effects on choice shares and attribute weights and hence welfare measures are not discussed.

[30] For example, we can extend the reasoning of Olsen and Swait (1998) and argue that if a compensatory choice rule is followed under the own brand format and a satisficing rule is employed under the 'no purchase' format, one would expect more non-linearities in the preference function measured with the 'own brand' than with the no purchase option.

the study aimed at examining the impact on individual food purchasing decisions from the introduction of percentages of genetically modified content into food products. Individuals may, thus, decide to stop or delay consuming a particular good if informed that it was genetically modified or that genetically modified 'inputs' were used for its production. For example, if informed that the chicken feed used for egg production contained a specific amount of GM content (that exceeded his/her subjective reservation level of 'GM-acceptance'), the individual may stop purchasing the specific good. Alternatively, some individuals may have strict *a priori* egg brand requirements (e.g. they only buy free range and organic) while others may overwhelmingly prefer their usual brand of eggs irrespective of the characteristics of the hypothetical brands offered. For these reasons the use of an opt-out alternative was deemed reasonable yet it was by no means clear which opt-out format to use. Would it be more suitable to use a no-purchase opt-put format (as used in all of the food-safety CE studies undertaken to date) or should we allow individuals to possibility to choose their usual brand? Therefore, the study was viewed as a suitable opportunity to examine the impacts on choice shares and attribute weights from the use of these two alternative opt-out formats. This was achieved by using of a split sample experimental design described in the subsections below.[31] Note that, it was decided from the outset to administer the survey via post.[32] Hence, the design efforts summarised below were undertaken with the specificities of such a survey mode in mind.

[31] Note that the study also had several other policy and methodological objectives. Most notably it aimed at identifying and investigating heterogeneous segments of consumers that would have different attitudes and values with respect to genetically modified foods. The issues of survey development that pertain to this question are described in detail in the next chapter. In this chapter we only focus on presenting the design issues that are pertinent to the examination of the impact of alternative opt-out options.

[32] This was decided mainly due to budgetary restrictions. The postal method has been extensively and quite successively used by economists and marketing experts when dealing with a subject matter that respondents are reasonably familiar with.

2.5.1 Consultations, focus groups, and pilot studies

The survey design processes began in February 2001 with a series of consultations with scientists from the genetic food industry (Dr. Pablo Eyzaguirre from the International Plant Genetic Resources Institute (Rome, Italy) and Dr. Tim Soellick from the Max-Planck-Institute (Cologne, Germany)[33] as well as with managers from two leading food retailers in the UK (Tescos and Sainsubury's) as well as the sales manager from a food retailer specialising in health and organic foods (Planet Earth). Additional meetings were held in other stages of the survey design process. The aim of these consultations were to determine (i) an appropriate good for examining trade-offs between GM content and other attributes (such as prices), (ii) the attributes and levels that should be used to design the choice profiles and (ii) the level of information that should be provided to respondents.

At the same time an extensive review of the literature on the economics of GM foods and food safety was being conducted. This consisted of reviewing mostly applied work examining issues of market segregation, labelling and certification[34]. One of the most prominent aspects of these issues that has concerned both the academic and policy journals has to do with the determination of the maximum GM content that would be allowed for a specific crop or food product to be granting GM-free certification. This percentage varies across the different countries with a range between 1 and 10%. The current threshold for all foods circulating in the EU is 1%. Yet, the importance of setting such unilateral thresholds is undermined by the influx of imported foods that originate from countries that follow considerably different GM food polices. In light of these problems, the EU is currently reviewing its own GM policy including ongoing discussions for raising the GM-free content level to 5%. Further, the majority of work on the issue of changing GM content threshold levels has been mainly preoccupied with the cost side of this change (e.g Bullock *et al.,* 2000, European Commission, 2000; Mooney and Klain, 1999; Franks, 1999,

[33] Also the work by Wolfenbarger and Phifer (2000) provided further insights into the ecological risk and benefits of the GM foods

[34] Most sources of information on the policy for GM foods is in the form of consultancy and governmental or agency reports. Published academic work on the economics, politics, and psychology of GM foods is highly absent. This is due to the relative novelty of the subject. Yet, the annual International Conference on Biotechnology, Science and Modern Agriculture organized by the International Consortium on Agricultural Biotechnology Research (ICABR) in Ravelo, Italy provided a highly comprehensive and up to date exposition of ongoing academic work in this field.

Nelson *et al.*, 1999). Moreover, considerable work has been undertaken on consumer attitudes and perceptions for alternative levels of GM content in foods[35]. Yet, very little work has been undertaken on the benefit side of the issue of affective GM content threshold levels. Hence, the CE experiment presented here aimed at providing a contribution to this neglected area of the GM policy debate. Finally, the literature review also extended into the valuation literature examining food safety issues. Valuation studies on GM foods are just starting to emerge and were virtually absent at the time the study was being developed.[36] In contrast there are quite a few contingent valuation (CV) and CE studies on various other food safety issues which provided useful insights on various design and administration procedures.[37]

On the basis of these consultations and the review of the literature on the economics of GM food and food safety a focus group protocol was designed. The protocol aimed at identifying the quality and quantity of knowledge that individual had over biotechnology in general and genetically modified foods in particular. In addition perceptions and attitudes towards GM foods were also ascertained as well as a first indication of how decisions over food products would be altered as the result of introducing various levels of GM content into foods. Finally, the good to be used as well as its scope was investigated. In total three focus groups session were conducted in April and May 2001. Twelve individuals participated in these sessions. The sessions lasted approximately 2.5 hours each and monetary compensation was provided to participants. Recruitment was undertaken in the central London area with most focus group participants originating from the University of

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[35] The GM attitudinal studies that were consulted were Lusk (2002), Hossain *et al.* (2002a, 2002b, and 2002c), Hallman (2000), Consumers' Union Report (2000), Veeman (2001), Heiman *et al.* (2000), Verdurme and Viaene (2000), Isaacs (2000) Sadler (2000), Kamaldeen and Powell (2000), ERSC (2000), Euro-barometer (2000), and Hamstra (1998).

[36] There are various studies that examine individual *intentions* to purchase GM foods (e.g. Hossain, 2002b; Verdurme and Viaene, 2002. A thorough review of these is provided by Wier and Anderson (2001). Yet *valuation* studies on GM foods are still in their embryonic stage with no clear results being published in peered review journals. The agricultural economics literature has recently acknowledged the need for valuation work in order to facilitate the GM foods debate (e.g. Lusk and Hudson, forthcoming 2003). Also, the conference organized by the International Consortium on Agricultural Biotechnology Research (ICABR) in Ravelo Italy for the past six years has revealed that numerous CV and CE applications on GM foods are in the pipe-line (e.g. Moon and Balasubramanian, 2001, James and Burton, 2001).

[37] Food safety, organic foods, and food labelling valuation studies that were consulted included those by Loureiro *et al.* (2001), Cason and Gangadharan (2000), Teisl *et al.* (2000), Latvala and Kola (2000), Huang *et al.* (1999) Kuperis *et al.* (1999), Caswell (1998); Ready *et al.* (1996) Huang (1996) and Chern (1995) Lin and Milon (1993), Eom (1994), Buzby, Skees and Ready (1995), Elnagheeb *et al.* (1992) Grobe *et al.* (1996) and van Ranvenswaay (1995). Also, the design of the experiment benefited from the review and assessment of food safety studies summarised in Wier and Andreson (2001).

London staff body. Both gender groups were included in the sessions while the mean age was thirty-eight years.

These initial design efforts confirmed the finding encountered in attitudinal studies (e.g. Verdurme and Viaene, 2002, Veeman, 2001; Heiman, *et al.* 2000) that the public has a varied and often erroneous understanding of biotechnology and GM foods. Hence, it was decided to present a common (benchmark) information level to each respondent (see below). Further, it was decided that it would be considerably less complex to design and administer a study that examined decisions with respect to one food product as opposed to decisions over food consumption in general.[38] The specific food product that was chosen was a box of six eggs. The CE study would examine the impacts on egg consumption decisions resulting from the use of chicken feed that contained various levels of genetically modified content.[39] This particular good was chosen mainly on the basis of its widespread familiarity and consumption across UK consumers. Also, the good has several well known and understood attributes compared say to a particular vegetable or fruit. Further, the selection of this particular good permitted investigation of consumer decisions over goods that have been produced with GM 'inputs' (e.g. live stock products) as opposed to examining decisions concerning GM crops themselves (e.g. soya, rice, corn). This makes the study particularly policy relevant since the designation of food products that contain GM inputs still remains an open issue.[40, 41]

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[38] Note that most studies on 'food safety issues' have also focused on specific goods rather than on broad range of goods. For example, Kuperis *et al.* (1999) on hormones in milk, Cicia *et al.* (2001) on pesticides in olive oil, Moon and Balasubramanian (2000) on GM content in breakfast cereals.

[39] So-called 'organic' eggs are produced with certified GM-free chicken feed (i.e. feed that contains between 1-5% of GM content). All other eggs (including free range eggs) are produced with chicken feed that has a GM content of 30%. This is so, since the bulk of chicken feed is imported from North and South America where segregation of crops such as corn is only practiced for specialised food markets (such as the organic food market). Hence the results from such a study would be relevant for the issues concerning GM food market segmentation, labelling and threshold content levels.

[40] Recent EU legislation treats livestock products (e.g. cheese, eggs etc.) that have been produced from GM feed (or other inputs) as GM free. Yet, this has been called into question by many consumer, environmental and scientific groups (see Isaacs, 2000; Kamaldeen and Powell, 2000; ESRC, 1999). Hence it is relevant to examine the degree to which individuals would also be WTP to avoid the use of GM cops even if used as an input. Resisting GM crops even as inputs would be compatible with sentiments of mistrust towards authorities, risk aversion, as well as environment and ethical concerns.

[41] Further the specific good provided the opportunity to explore the impact of animal welfare concerns (in addition to health, environmental, and moral concerns) on decisions over GM foods. This could not have been investigated if the study used a vegetable or fruit. Finally, the use of eggs allowed comparison with the results from other valuation studies on egg consumption (Rolfe, 1999; Bennett, 1995, 1997, 1998; Bennett and Larson, 1996; Wang, 1996).

The survey design process concluded with a series of pilot studies that addressed issues of wording, framing, attribute level determination, information level and quality assessment, survey length, administration method and sampling procedures. A first pilot was undertaken in June 2001 consisting of a convenience sample of 35 respondents recruited from the congregation of a central London church. Willingness to pay for particular egg brands was ascertained using a CV payment-card while the drop off method was used to administer the pilot survey. A second pilot was conducted in July 2001 consisting of 123 university students. The pilot offered the chance to test a draft version of the CE survey. The pilot was administered in groups of students (with no between subject interaction) that received a common presentation. A final pilot was conducted in August-September 2001 in which we tested the questionnaire that was to be used for the final survey. Finally, since the final survey was to be administration via mail the last pilot also provided a test of the administration and sampling strategy that would be used. In total 1000 survey packets were sent out. The response rate was a modest 13% that may be explained by the unfortunate timing of the pilot (many respondents were away on holiday) as well as the absence of any of the incentives commonly used in mail surveys.[42] The overall results of the pilot, however, suggested that the questionnaire performed well in the field and that the variability in the choice sets permitted satisfactory estimation of the effects of egg attributes on individual utility.

[42] The survey budget only permitted the use of such incentives for the final survey.

2.5.2 Choice set and experimental design

The final set of attributes and levels was determined from the consultations, focus groups, and pilot studies mentioned above. The number of levels chosen aimed at achieving a balance between choice set efficiency, correspondence to market realism and enhancement of the variability of each attribute.[43] In total five attributes were selected, three of which were binary while the remaining two took on four values. The set of attributes and levels is listed directly below:

1) Living condition of hens: free range Vs cage
2) Use of agricultural chemicals and fertilizers in the production of chicken feed: no use (organic) Vs use (non-organic)
3) Certification of health standards and quality of eggs (e.g. the 'Lion Quality' mark on egg shells and egg boxes): included Vs not included
4) GM content in chicken feed: 0%, 5%, 1% and 30%
5) Price: £0.38, £0.68, £0.98, and £1.28

The characteristics of 'box size' and 'egg size' were held constant. Hence each profile consisting of a box of six medium-sized eggs. A fractional factorial design prescribed in Louviere *et al.* (2000, p. 111-120 and 131-137 and Louviere 1998) was used to create 32 choice sets that contrasted two different egg profiles. One of the characteristics of this particular design is that it allows for the independent estimation of all main-effects and two-way interactions.[44] In order to reduce task complexity it was decided to present each individual with only eight choice sets or occasions.[45] Hence, the set of 32 choice sets were randomly blocked into four versions (i.e. of eight choice sets each). The sample was then randomly divided into four groups with each sub-sample receiving one version. To increase the efficiency of the resulting choice model a third fixed option was added to each chose set (see Louviere *et al.,* 2000, ch.5). This option was held constant *within* each

[43] See Louviere *et al.* (2000, ch.5) and Louviere (1988) for a discussion on optimal level determination.
[44] The 'design catalogue' that was used as the basis for the design the CE study presented in this chapter can be found in an application by Olsen and Swait (1998). The authors used this design to estimate main and two-way interaction effects in a choice model that examined consumer preferences for alternative orange juice profiles.
[45] The pilot studies suggested that eight choice sets was the maximum number that individuals could cope with. The optimal number of choice sets presented to individuals ranges between four to even as high as sixteen depending on the complexity of the task and the good involved (Bateman *et al.*, 2003; Adamowicz, 2000).

version but varied *across* versions. In total three such fixed options were used. The first represented a high price-quality alternative that dominated all other alternatives. It consisted of the characteristics of 'free range', organic, 0% GM content, certification mark included on box and a price of 136 pence. The second represented a 'generic' brand of eggs that was constructed on the basis of the initial market research efforts mentioned in the previous section. It consisted of the characteristics of 'free range', non-organic, 5% GM content, certification included mark on box and a price of 78 pence. The third also represented a generic brand but consisted of eggs from hens that are kept in battery cages (instead of coming from free range hens). The introduction of these particular fixed options would allow for the testing of the second hypothesis of Section 2.4.

Finally, the choice set included a forth option which allowed individuals to opt-out. A split sample design was used such that each treatment would receive a different opt-out alternative. The first treatment (TA) would receive a 'no purchase' alternative while the second (TB) a 'buy my regular brand' alternative. The choice sets across treatments were identical apart from the format of the opt-out alternative. The respondents in the former treatment were informed that the options included in each choice occasion were the only ones available and that choosing D implied that they would not purchase any eggs when faced with these alternatives. Respondents in TB were informed that choosing option D amounted to selecting their own brand. Moreover, revealed preference information on the characteristics of respondent's own brand of eggs was collected. The information on egg characteristics provided in the revealed preference section corresponded to the attributes included in the hypothetical choice sets. Note that the choosing the 'my own brand' option requires modelling of the characteristics of the favourite brand as well as developing a link between the stated preference model and a revealed preference model (Adamowicz and Boxall, 2001). The complete description of the all four choice set versions is presented in Table 2.1.

2.6. Questionnaire material and survey administration

The final questionnaire consisted of four sections: (a) a section that obtained revealed preference egg consumption data; (b) a section explaining the choice experiment exercise in terms of an imaginary shopping trip. This included explanation of the attributes and levels of the egg profiles as well as a diagrammatic 'simulation' of how to complete the choice sets; (c) the section with the eight choice set questions. This was the only section that differed across the four questionnaire versions; and (d) a section with questions on individual attitudinal and demographic characteristics. This last section will be explained in more detail in the next chapter where we will explore the issue of accounting for preference heterogeneity in random utility models. A copy of one of the survey versions is included in Appendix 2. The 'Total Design Method' of Dillman (2000) and the prescriptions of Mangione (1999) for administrating a postal survey were closely adhered to in order to maximise response rates, minimise item non-response and enhance sample representativeness.[46]

First, a pre-notification letter was sent out explaining the aims of the study, the institution undertaking the exercise, the means by which their household was sampled, and the importance of completing and returning the questionnaire.[47] Approximately two weeks after the pre-notification letter had been dispatched the 'questionnaire packet' was sent out. This consisted of (i) a cover letter that re-iterated the points made in the pre-notification letter but also explained the procedure for completing and retuning the survey; (ii) an information booklet that provided a brief, balanced and non-emotive exposition of the possible benefits and risks to humans and the environment from cultivating and consuming genetically modified foods; (iii) a copy of one of the four questionnaire versions together with self addressed envelope with prepaid postage; (iv) two 'incentives' prescribed by Dilman (2000) and Mangione (1999) to enhance response rates. These consisted of a complementary pen with university logo and a lottery post card that allowed those that completed the survey to enter a draw for a gift voucher worth £50.[48] Finally, two reminder packets were sent out at two-week intervals after the first round had been dispatched. These packets only included a reminder cover letter and one of the four questionnaire versions (together with self addressed return envelope with prepaid postage).

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[46]For example, pre-notification and cover letters were printed on correspondence paper using official University letter head and were individually signed by the institute's director (i.e. CSERGE-UCL, Prof. David. W. Pearce). Also, the questionnaire was printed on coloured paper using appropriate font size and spacing (see Dilman, 2000 and Mangione, 1999).

[47] Undeliverable pre-notification letters revealed wrong addresses which were replaced with another household.

[48] It was made clear to respondents that four such prizes would be awarded. Also, the lottery post card (that included name and address) was to be returned separately from the completed questionnaire. This preserved the anonymity of their survey responses. There is always the possibility that some people return the lottery post card but do not complete and return the questionnaire. Yet, this is not usually encountered in most postal surveys (see Mangione, 1999) and was not observed in the study either.

2.7. Sampling strategy

The sampling strategy that was followed was based on the multi-stage procedure suggested by Lynn and Lievesley (1991). This approach is tailor made for drawing samples in Great Britain. The first step of the sampling strategy involved selection of seven sampling locations. Four of these were urban and three rural areas and listed in Table 2.2. Secondly, these locations were divided into primary sampling units (PSUs) on the basis the number of post-code areas they included. In total, these seven locations contained 418 PSUs. This corresponds to the sampling universe. Thirdly, a total of 80 PSUs were randomly sampled. The number of PSUs selected from each sampling location was determined on the basis of its relative weight (determined by its relative PSU and relative population weights).[49] Finally, 25 households were randomly selected from each of these 80 PSUs. The final list of addresses was extracted from the UK Info-Disk Professional (2000 edition). This process generated a sample of 2000 households (1000 for each opt-out treatment). The four questionnaire versions were randomly assigned to each household such that 250 households from each treatment received one survey version.

2.8. Response rates, sample composition and representativeness

The response rates from the two treatments were 33 and 31% respectively. These rates are more than double than that obtained in the pilot (i.e. 13%), which suggests that the inducements and reminder letters used for the final survey did in fact increase the response rate. Still, the overall final response rates remain relatively low compared to other CE studies. Yet, the only other known CE postal study on GM foods also had a modest response rate of 18% (see James and Burton, 2001). Hence, provided that there is no methodological shortcoming in the design of the study or some other sampling or administrative flaw, then the modest response rates may be attributed to limited interest in the issue of GM foods.

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[49] Lynn and Lievsesley (1991) recommend using a minimum of 50 PSUs for social surveys in Great Britain in order to increase the sample precision.

Moreover, the sample composition in terms of socio-demographic and attitudinal characteristics was virtually identical across samples (see Table 2.3). Hence, we can reasonably conclude that the two samples are identical in terms of their socio-economic and attitudinal make up.

In addition the overall representativeness of the two treatment groups (i.e. compared to the overall population) seemed very satisfactory. The data received for age, education, family size, number of children, and income are quite representative (Table 2.3). Notice from the same table that there is a relatively higher representation of females in the sample. This is expected since we had asked for the main grocery 'shopper' to complete the survey. Also, the data on revealed egg consumption patterns is highly representative as compared from the data published by the British Egg Information Service (see Table 2.4). Finally, there is a credible indication that the attitudes towards GM foods held by these two treatment groups are closely aligned with those of the general population. The CE survey included five attitudinal questions that were taken from a recent Euro-Barometer questionnaire that sought to examine European perceptions and attitudes towards GM foods (EuroBarometer 2000). By incorporated these questions in the CE survey it was able to externally validate, so some degree, the attitudes towards GM foods held by the individuals in the sample (see Table 2.3).[50]

With respect to item non-response we see that only 6.5% of the sample did not complete the CE questions while the missing data on socio-economic variables was quite low (between 2% and 6% on key variables; see Table 2.3 and Table 2.6). Observations with missing data were excluded from the sample. The final number of usable questionnaires in each treatment (after accounting for missing data) was 312 for TA and 270 for TB .

2.9. Response patterns and choice shares

We now turn to examine the first three propositions set out in Section 2.4 (H_1 to H_3), on the possible differences in choice shares across opt-out treatments. Looking first at the last column of Table 2.5 we can see that the second treatment returned nearly double the proportion of opt-out responses compared to the first treatment (47% compared to 26% respectively).[51] Further, looking at Table 2.6 we can see that the proportion of respondents that chose the opt-out alternative in *each* of the eight choice set questions is more than three times higher in TB than in TA (22% and 6% respectively).[52] Such a pattern across treatments does not appear to exist for the other options.[53] These results provide initial indication that the 'no-purchase' format may have been perceived as a forced choice and thus may have induced respondents to choose one of the other hypothetical alternatives A, B, or C. Hence, it appears that there is support for the first proposition stated in Section 2.4.

We now turn to examine whether the use of alternative opt-out formats induces a *systematic* favouring of some options at the expense of others. That is, we examine from which options does the opt-out alternative in TB draw its relatively high share and to what other option(s) does the opt-out alternative in TA loose its relatively low share. An implicit assumption made in most applied choice experiment work is that alternative opt-out formats will draw proportionately from all options. Yet, if this is not the case (and some alternatives are systematically favoured over others when a particular opt-out format is used), it is vital to understand why this may be so as well as the direction of the bias. Going back to the last column of Table 2.5 we see there is a 21% difference in the share of D across treatments. We see, however, that the respondents in TA have allocated 15% of this percentage difference to option C (the fixed alternative option) and merely the remaining 6% proportionately to the (variable) options A and B. Moreover, Table 2.6 shows that the proportion of individuals that chose option C in *each* of the eight CE questions was substantially higher in TA compared to TB (15% Vs 8% respectively). There is, thus clear evidence that there is a systematic gravitation towards the fixed choice alternative when individual's are provided with the 'no-purchase' option compared to those offered the 'own-brand' opt out alternative.

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[50] This is, of course, a rough form of external validation since the Euro-barometer is a survey itself with its own degree of sampling error. Yet, the Euro-barometer sample was considerably larger and even more representative than the one used in this study.

[51] A one sided test of proportions (independent samples) cannot reject the null hypothesis at the 0.01% level.

[52] Again a one sided test rejects the null that "% of all D responses in TB >% of all D responses in TA " at the 0.05 level

[53] That is, the percentages of respondents that chose either a non response, A's, B's of C's in *each* chose set are similar across treatments.

The experimental psychology literature briefly reviewed in Section 2.2 provides some insights as to why this may be the case. As explained, when individuals perceive the choice setting as involving a forced choice, they tend to adopt simplifying heuristics (e.g. compromising behaviour) that aim at minimising adverse and unpleasant psychological effects such as 'regret'. The results from this particular decision making processes is that options that are perceived as being 'generic', or high-price high quality or asymmetrically dominating in one dimension are systematically favoured at the expense of other alternatives. In the current study we used three types of fixed alternatives: a generic brand of free range eggs, a generic brand of battery cage eggs, and a high quality and price brand. The aim of using three different fixed choice alternatives was to be able to examine the extent the findings from the psychology literature mentioned above are relevant for the comparison between opt-out alternatives. Table 2.7 presents the choice shares across treatments broken down with respect to the type of fixed alternative included in the choice set. Starting with the first column we see that the high price high quality option draws the highest share in both treatments (compared to the other fixed alternatives). Though this share is considerably higher in TA than TB (45% Vs 29%) we see that the choice share of C in TB is significantly higher than the corresponding share in the overall sample (17%). This signifies that the effect of introducing a high price/high quality alternative may provide respondents with an attractive outlet for both treatments. Further it is clear that the high share of C mainly draws from option D (i.e. the opt-out alternative) in both treatments. Yet, this effect is considerably smaller in TB than in TA suggesting that the psychological inducements that are responsible for this bias are weaker in the second treatment. The psychological causes for gravitating towards such responses have been attributed to the ease in justifying once choice, the avoidance of criticism, and the minimisation of error and regret (see Section 2.4).

Moving on to columns two and three in Table 2.7 we can examine the effect of introducing a generic fixed brand alternative. Interestingly, we see that the patterns of systematic bias in favour of the fixed alternative are only present when this contains the 'free range' characteristic. That is, when the fixed alternative is generic but includes the battery cage characteristic, the share of the opt-out alternative in TA drops by 23 percentage points compared to the total sample figure (32% Vs 9%). Similar patterns are witnessed in TB. The 'loss' in the share of C is spread mainly to option A and to no-response. When the generic fixed alternative, however, includes the free-range characteristic the overall pattern of systematic preference for option C in TA remerges (i.e. the choice shares when C contains the free range characteristics are equivalent to those observed in the entire sample). It appears, therefore, that individuals faced with a forced choice (i.e. under TA) tend to anchor on the 'free range' characteristic. This is compatible with the finding from experimental psychology literature that asymmetrically dominating alternatives are chosen when the individuals are uncertain about their preferences *and* are forced to choose. Such a bias does not appear to be present in the 'own-brand' treatment. [54] We can, thus, conclude that the second proposition of Section 2.4 cannot be rejected.

Lastly, the patterns in the percentages of opt-out responses as we move from the first to the eighth choice set question suggests that respondent fatigue is present in both treatments.[55] However, we can see that the presence of fatigue effects (defined as an increasing share of the opt-out alternative as individuals answer repeated chose set questions) is considerably weaker in the TB compared to TA. The percentage of D responses in TA for the first two CE questions is on average 18% while that for the remaining six CE questions is 32% (a 77% increase). Conversely, the percentage of D responses in TB for the first two CE questions is on average 37% while that for the remaining six CE questions is 49% (a 32% increase). This confirms the third proposition of Section 2.4 that respondent fatigue may differ across samples presented with alternative opt-out formats. Moreover, the results suggest that respondents in the 'own brand' treatment exhibit higher response consistency and respondent endurance than those faced with the no-choice option. This may be due to the more realistic and less restrictive choice setting provided by the 'own brand' format.

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[54] The anchoring on free-range characteristics could also be due to the position it had (it was first) in the exposition of the various profiles. Further research is required on the relationship between the positioning of vital characteristics within profiles and the impact of asymmetrically dominating alternative across opt-out treatments.

[55] The patterns of all other choice shares across the series of eight choice set questions suggests that shares remain relatively constant

2.10. Estimation of multinomial models

We now turn to examining the last two propositions stated in Section 2.4 on the effects of using alternative opt-out formats on the estimated parameters of the multinomial choice model derived from the CE data. The first subsection below presents the estimation procedure that was followed while the second discusses the obtained results.

2.10.1 Estimation procedure

Two separate multinomial models were estimated for each treatment group. In order to avoid the danger of the IIA violations cuased by the introduction of the opt-out alternative a random parameter logit model was employed (Revelt and Train, 1998). [56] The random utility function with random parameters is give by:

$$U_j^n = V_j + \varepsilon_j^n \equiv X_j(\beta + \eta^n) + \varepsilon_j^n \qquad \text{Eq. 2.1}$$

Where individual n (n=*1*...*N*) obtains utility U from choosing alternative j (*j=A, B, C or D*) in each of the eight choice occasions. The utility is decomposed into a non-random

[56] Our main concern in selecting a particular multinomial model is to avoid problems from violations of the IIA property. The results from the previous section showed that the relative shares of the various alternatives were not invariant with respect to the opt-out format that was introduced. Hence, it is likely that the IIA property does not hold. This was in fact confirmed by using a standard IIA test on the results of the standard multinomial logit model. This test used is based on the procedure outlined by Hausman and McFadden (1984). The reasoning of the test suggests that if a subset of the choice set is truly irrelevant, omitting it from the model altogether ill not change parameter estimates systematically. Inclusion of these choices will be inefficient but will not lead to inconsistency. Yet, if the remaining odds ratios are not truly independent of these alternatives, the paymasters estimates obtained when these choices are eliminated will be inconsistent. The test statistic is given by: $\chi^2 = (\hat{\beta}_s - \hat{\beta}_f)'[\hat{V}_s - \hat{V}_f]^{-1}(\hat{\beta}_s - \hat{\beta}_f)$ where s indicates the estimators based on the restricted subset, f indicates the estimator based on the full (unrestricted) set of choices, and V_s, *and* V_f are the respective estimates of the asymptotic covariance matrices. The test statistic follows (asymptotically) a chi-squared distribution with K degrees of freedom, where K the number of restrictions. In the current data set we ran the test by defining the restricted choice set that which does not include the opt-out alternative. The test statistic is given by 24.6 which entails that the null hypothesis that IIA holds can be rejected. Hence, we used the RP logit model that does not evoke the IIA property. The nested logit model was not used since the tree structure that it is based upon is not appropriate for choice sets that include with no-brand alternatives. Note that the RP logit also has the added advantage of accounting for preference heterogeneity. Finally, despite the advantages of using the RP logit we must acknowledge its main shortcoming, which is that it imposes stringent distributional assumptions on the error structure. The implications of this assumption is discussed in greater detail in the next chapter where the issue of preference heterogeneity is explicitly tackled.

component (V) and a stochastic term (ε). In its most simplest form the non-random component is assumed to be a function of the choice attributes X with parameters β which due to preference heterogeneity may vary across respondents in accordance to some random component η. By specifying the distributions of ε and β (or η) the probability of choosing the option j in each of the eight choice occasions can be derived (Revelt and Train 1998). The estimation procedure was programmed in LIMDEP. The programme code is included in the Appendix 3. In order to identify the parameters the scale parameter, μ^n, was normalised to equal one. Moreover, the β random parameters were assumed to be independently normally distributed and distribution simulations to derive the moments of the distribution were based on 500 draws.[57]

A simple specification was used that models the probability of selecting a particular alternative as a function of choice-specific attributes (which may be random) and a non-random alternative specific constant (ASC).[58] Since the choice experiment involves "no name brand" options the ASC is not choice specific but equals '1' when either A, B, or C are chosen and '0' when D (i.e. the opt-out alternative) is selected. This constant would account for the proportion of choices A, B, or C relative to D not otherwise explained by the data. Also note that a relatively more negative and significant ASC across treatments would indicate a higher propensity to choose the opt-out option in that treatment.

Turning to the issue of coding the data, the attributes that had two levels entered the utility function as binary variables but were effects coded, that is: 'Living conditions' (free range = 1, cage = -1), 'Use of agricultural chemicals and fertilizers' (non use = 1, use = -1), and 'Certification' (yes = 1, no = -1).[59] The levels used for the 'price' and 'GM content'

[57] Most applications of the RP logit model assume that the random parameters are normally distributed. Other commonly used distributional assumption is the lognormal distribution. In theory any distribution may be assumed as long as the implication of this assumptions are acknowledged. For example the normal distribution allows for a positive density between minus and plus infinity, which implies that the sign of the realized parameter can vary across individuals. The log normal distribution on the other had would restrict the sign to be the same for all individuals. Which is most appropriate depends on the application.

[58] The impact of individual characteristics on the probability of choice is explore in the next chapter.

[59] According to Adamowicz *et al.* (p, 281, 1994) and Louviere *et al.*, (p. 267, 2000) effects coding should be preferred to the 1, 0 dummy variable coding since the latter because (a) 1,0 dummies confound the alternative-specific constant with the effects of interest; whereas effects codes orthogonise the attribute effects to the constant, (b) effects codes simply contrast the parameter estimates with one of the levels; whereas 1, 0 dummies contrast the estimates with the constant, and (c) interactions defined from effects coded columns are orthogonal to their respective main effects and other estimable interaction effects; whereas 1, 0 coded dummies are not.

attributes were entered in a cardinal-linear form. The price attribute took the values (in pence) 38, 68, 98, 128, and 136 while the GM attribute the values (in percentages) 0, 1, 5, and 30 (see Table 2.8).[60] Further, whilst the attributes for the opt-out option in TA were simply coded with zero values, the attributes for opt-out option in TB were coded with the actual product characteristics specified by each individual in there responses to the revealed preference questions.[61]

Finally, in order to facilitate comparison of models across treatments the parameter estimates had to be re-scaled by a common coefficient (see Swait and Louviere 1993). This is so because the scale parameters across each sample may differ and hence comparisons of raw parameter estimates may be misleading. To re-scale the parameters and compare coefficients from different samples we follow the approach of Swait and Louviere (1993). One of the attributes in each model, price, is retained fixed (while the rest are allowed to be random) and is used to rescale the other parameters. The significance of the difference between attributes parameters can be assed by a t-statistic. The standard error required for its estimation was obtained from 1000 draws on each multivariate normal parameter distribution.

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[60] Alternative functional forms for these two attributes (e.g. quadratic, logarithmic, mixed distribution etc) were also explored and are discussed in the next chapter.

[61] The ubiquity of this good was one of the main reasons for choosing it for this particular comparative study since it would be likely that individuals were highly familiar with the characteristics of the egg brands they commonly bought. This in fact was confirmed in both the focus groups and pilot studies where individuals gave remarkable accurate price and other attribute descriptions of their egg brands. The completeness and accuracy of the revealed preference data was enhanced in the final survey by the fact that the vast majority of the people that completed the questionnaire were the members of the household that performed the weekly shopping. Finally, the accuracy of the egg characteristics that respondents claimed to prefer was externally validated by asking respondents to state the supermarket chain they regularly purchased eggs. The vast majority of the sample (94%) purchased eggs in the UK's leading supermarket chains (namely, Asda, Iceland, Marks&Spencer, Safeway, Sainsbury, Somerfield, Tesco, and Waitrose). Comparison of the data provided by the survey on egg characteristics with the characteristics of the eggs sold in the above food retailers suggests that individuals had a highly accurate awareness of the type of eggs they purchased. There were two issues however that had to be dealt with in coding the data for the opt-out alternative in TA. First, many respondents were not certain of the GM content used in chicken feed. This is to be expected considering that the issue of GM content in foods is not as familiar as that of. say, pesticide content or salmonella-free certification. The missing revealed preference data on GM content were coded as follows: those who stated that they purchase 'organic' eggs were coded as choosing ages with 0% GM content while the others were assigned a 30% GM content level since this is the level that is estimated to exist in non-organic chicken feed used in the UK. In fact, individuals were informed through their information packet that non-organic chicken feed in the UK has a 30% GM content. Hence, the consequences of buying one's own brand (with respect to GM content) was made explicit. Secondly, since respondents provided price data for different box sizes, it was necessary to convert all price data into prices for a box of six eggs (the unit of scope used in hypothetical egg profiles).

2.10.2 Estimation results

Table 2.9 presents the results from the two estimated random parameter models. Examining first the overall fit of the two models, the TB model outperforms the TA both model in terms of McFadden's and Madalla's pseudo R^2 criterion.[62] The poor overall fit of the TA relative to the TB model is consistent with the observation that the former model exhibits fewer significant main effects variables. More specifically, the parameters on 'Information' and 'Pesticides' are both highly insignificant under TA while under TB model only the 'Information' attribute is insignificant.[63, 64]

Further, the signs of the significant main effect variables in both models have the desired direction. The effect on utility from choosing a box of eggs that is 'free range' and 'organic' is positive while that of rising GM content and price is negative. Also, note that in both treatments the price attribute has the largest utility weight while the "GM Continuous" attribute the lowest.[65, 66]

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[62] The R^2 measures of goodness of fit are not very reliable for non-linear discrete choice models (see Ben Akiva and Lerman (1985) and Amemiya (1981) for a discussion of goodness to fit measures for multinomial choice models). Yet, what is important here that the differences in the pseudo R^2 between the two models is significant.

[63] Note that alternative econometric specifications (such as a RP logit *without* two-way interactions) exhibit a significant parameter for the 'Information' attribute. Yet, even in these cases, the parameter in 'Information' was considerably *less* significant than the other parameter attributes.

[64] The reason why the attribute on 'Pesticides' is significant in TB (as opposed to TA) is attributed to the fact that a large proportion of respondents in this treatment that chose to opt-out (i.e. "own brand") buy organic (no pesticides) eggs (see Table 2.4).

[65] The estimated coefficients of a multinomial logit model incorporate an unidentifiable multiplicative scale factor that is inversely related to the variance of the error term. This makes it difficult to directly compare multinomial logit coefficients estimated from different data sources, since differences in parameters can be attributable to scale factor differences and/or to true parameter differences. That is the 'raw' coefficients for the two treatments will be $\mu^i_{TA}\beta^i_{TA}$ and $\mu^i_{TB}\beta^i_{TB}$ and it be improper to make any comparisons without knowing the ratio of the two scale factors, μ_{TA} and μ_{TB}. However, using the procedure outlined by Swait and Louviere (1993) it is possible to test for overall parameter equality across treatments while controlling for differential error variances. The test indicates that the coefficient vectors in the two models *differ* at the 95% confidence level (the test statistic of 34.69 is asymptotically chi-squared distributed with 20 degrees of freedom, for which the critical value is about 31.41). This supports the inference that the attribute weights across treatments differ more than can be explained due to error variance differences between the two conditions.

[66] Note also that the derived standard deviations of the random parameters are not significant in both treatments which indicates that preference heterogeneity may not be accounted at the individual level. We will see in the next chapter that for the specific application preference heterogeneity may be best explained at the segment or group level while the source of heterogeneity can be traced to latent attitudinal characteristics of the individual. Yet, for the purposes of comparing opt-out treatments we will retain the RP logit model

In addition, we can see that the ASC coefficient in the TA model is insignificant (and positive) while the same parameter in the TB model is highly significant and negative. This suggests that there is a higher likelihood that people would opt-out in TB than in TA, thus confirming the patterns of opt-out shares discussed in Section 2.9. More importantly, the results on the ASC parameter can be interpreted as implying that the decision making process of individuals in TB is more aligned with rational choice theory that that followed in TA. The structure of the multinomial choice random utility model implies that the probability of opting-out is inversely related with choice set quality. The latter is captured by the utility scores associated with each alternative. Hence, a negative and significant ASC implies that individuals are highly responsive to changes in choice set quality and are thus making decision that are closer both to rational choice theory and to behaviour observed in real markets (Dhar, 1997; Huber and Pinnell, 1994a).

A more valid comparison of the estimated parameters of the main-effect attributes across the two models can be observed in Table 2.10 that presents the re-scaled parameters and the significance level of their differences. The rescaling was performed with respect to the price attribute and nullifies the potential differences in the scale parameters across models.[67] It can be seen from Table 2.10 that the differences between the parameters on 'living conditions' and 'pesticides' obtained from the two models are significantly different from zero. This suggests that when respondents are given the choice of specifying an alternative brand (i.e. when allowed to choose their own brand) they are more likely to specify a brand with these characteristics, thus increasing the salience of

since it avoids the IIA violation documented of the basic multinomial logit model documented in Footnote 56.

[67] As pointed out by Swait and Louviere (1993), the estimated coefficients of multinomial choice models (including the RPL) incorporate an unidentifiable multiplicative scale factor that is inversely related to the variance of the error term. This makes it difficult to directly compare the utility coefficients estimated from different data sources, since differences in parameters can be attributable to scale factor differences and/or to true parameter differences. Hence, a rescaling procedure is applied that nullifies the effects of the scale parameter so that any differences in attribute weights across the two treatments are not confound to error variance differences. This procedure simply consists of rescaling each model by a common coefficient. In our case the attribute on 'price' is selected as the base parameter that will be used to rescale all the other parameters. Fro simplicity the 'price' variable was set as being non-random (fixed) in estimating the two RPL models. Its estimated parameter (or more precisely the negative of its parameters) was then used to divide the estimated (random) parameter vector in each treatment. By taking the ratio we can eliminate the scale factor for the data set in question and it is now valid to examine the differences between attributes across treatments. Standard errors of the differences are obtained from 1000 draws on each multivariate normal parameter distribution.

these attributes. If, for example, consumers prefer organic eggs, then it is most likely that they will choose hypothetical brands that are organic. Yet, presented with a CE question that describes hypothetical alternative brands that do not include this characteristic, they may opt-out and specify their own brand which is known to have the desired characteristic. This increases the salience of the 'pesticide' attribute (which is coded with '1' when organic). Hence, when given a choice of specifying an existing brand, respondents tend to choose brands that are free-range and organic. Moreover, we see that the parameters of 'GM content' and 'information' are *not* significantly different across treatments. We have noticed, however, that the size of the 'GM content' parameter is the smallest compared to all other attributes while the 'information' parameter is insignificant in both treatments. We can, thus, conclude that the choice of the format of the opt-out alternative does in fact affect parameter salience for attributes that are relatively more important while does not affect parameter salience for attributes that are of relatively less importance to consumers.[68] This lends support to the fourth proposition in Section 2.4 that there is good reason to expect that the choice model parameters across opt-out treatments would differ.

Finally, we can further corroborated the finding that the individuals in TB seem to be more aligned with conjunctive decision making strategies by examining the estimated coefficients of the two-way interactions. Looking again at Table 2.9 we see that the TB model exhibits six significant two-way interaction terms (out of a total of nine) while the TA model exhibits merely three. Hence, the richness of information contained in these extra interaction effects is not conveyed in the model derived from the treatment with the 'no purchase' opt-out format. Moreover, the presence of a higher number of significant two-way interactions (or non-linearities) in the utility function of TB suggests that individuals in this treatment are to a larger degree (compared to those in TA) relying on conjunctive decision making rules and to a lesser extent on simplifying heuristics. The opposite implication can be drawn for subjects in TA where individuals faced with an apparent contrived and restrictive choice setting (akin to a forced choice setting) resort to compromising heurists (such as the anchoring on the free range dimension discussed in

[68] This finding is also confirmed in the work by Banzhaf *et al.* (2001). It is also consistent with the results presented in Olsen and Swait (1998) that support the idea that, depending upon the types of decision rules used by consumers when faced with a forced choice, important attributes (i.e. under free choice) can either become inflated (if they lend greater importance to primary conjunctive attributes) or deflated (due to the use of attributes other than primary conjunctive ones to resolve preference ambiguities) compared to the NPA present case. This deflation or inflation may have a consequent impact on attributes of secondary importance, by respectively, inflating or deflating them.

Section 2.9). Hence, the fifth proposition of Section 2.4 that the 'no purchase' format would identify less interaction effects than the 'buy my own brand' format seems to be confirmed.

2.11. Discussion and concluding remarks

The decision 'not to choose' is an integral part of almost all forms of transactions. This decision can assume various formats, the two most common being the decision not to purchase any of the available alternatives and the decision to purchase an alternative or one's own brand. In the pursuit of enhancing the realism and theoretical credibility of choice experiment studies, non-market valuation practitioners have increasingly included an opt-out alternative in the experimental design of their choice sets. Moreover, almost all such CE applications have used the no-purchase format, implicitly assuming that the decision over which opt-out format to use has little bearing on the estimated choice shares and attribute weights. Yet, there are theoretical reasons (both from rational choice theory used by economists but also from other theories used mostly by experimental psychologists such as constructive preference theory) of why the introduction of different op-out formats may affect how individuals perceive the choice set. This in turn may impact both on the estimated choice shares and the attributes weights. It is thus crucial that CE practitioners gain an enhanced understanding of these effects as well as the circumstances that are more appropriates for the use of each format. This need has been acknowledged to be an important yet neglected methodological design issue (e.g. Adamowicz and Boxall 2001). The current chapter aimed at addressing this issue by assessing the impacts on CE data when alternative opt-out formats are used. More specifically, a split sample experimental design was used in a CE study on the consumption of alternative brands of eggs. The choice sets presented to respondents included two varying eggs profiles, A and B, as well as a fixed third alternative, C. These choice sets were identical across treatments except for the format of the opt-out alternative (option D). The first treatment received the no-purchase opt-out format while the second the buy my own brand format.

The results from the analysis of the data showed that the relative choice share of the opt-out alternative was higher in the 'own brand' treatment as opposed to the treatment that received the 'no purchase' treatment. One of the reasons behind this finding is that the no-purchase format appeared to be perceived by some individuals as entailing a more restrictive or forced choice setting. This was found to systematically bias respondents to select certain types of responses from the choice set at the expense of others. More specifically, respondents in the no-purchase treatment were found to systematically favour the fixed option over the opt-out alternative. This was the case when the fixed alternative was either a high price-high quality alternative or a generic brand that asymmetrically dominated the other options with respect to one characteristic/dimension. It was shown that the introduction of the own brand opt-out alternative took disproportionately greater share from options that individuals tended to select under the no-purchase alternative.[69] These findings are consistent with numerous robust results derived from the experimental psychology literature that have found that options selected under a contrived and forced choice setting (as may be the case in the no-purchase treatment) tend to be those that are "safer" and help alleviate decision conflict, discomfort, and potential regret associated with making a choice. In other words, such options are not primarily selected because of the utility embedded in their attribute values, but rather, because they help the consumer make a decision under preference uncertainty to comply with a forced choice task (e.g. Dhar and Simonson, 2001; Bettman *et al.,* 1998).[70]

Moreover, respondent fatigue (defined as an increasing share of the opt-out alternative as individuals answer repeated chose set questions) was found to be most prevalent in the no-purchase treatment while respondents in the 'own brand' treatment exhibit higher response consistency and respondent endurance. In addition, parameter attributes obtained from estimating separate random parameter logit models for each treatment appeared to vary significantly across treatments. It was found that the type of opt-out alternative that is used affects parameter salience for attributes that are relatively more important while does not affect parameter salience for attributes that are of relatively less importance to consumers. This finding is also supported by the work of Banzhaf *et al.* (2001), Olsen and Swait (1998) and Dhar (1997). Finally, the estimation of the choice model for the own brand treatment revealed a considerable higher number of significant non-linearities (such as

[69] This bias may have significant policy implications. For example, in cases where the policy analyst is interested in examining the impact of introducing a high quality alternative on the share of existing low quality options, she may overestimate that impact if a no-purchase format is used. Also, these results are equally relevant for studies examining voting intentions (as opposed to preferences over consumer goods). Krosnick (2000) has shown that surveys with and without the opt-out alternative can result in significant differences in voter intentions. In many cases the use of the own brand format (e.g. choose my usual option that is not offered in the choice set) is not conceptually appealing. Yet, there are other numerous cases (e.g. voting over local public goods) that the own brand format may be relevant. Hence, it remains to be seen how alternative opt-out formats affect the results from opinion polls and voting studies.

[70] Hence, the study also confirms that the non-market valuation literature can gain very useful insights from exploring research undertaken in other fields, primarily from experimental psychology. This underlines the

attribute interaction terms) in the utility function compared to the no-purchase opt-out treatment. This suggests that individuals in the no-purchase treatment resort less to conjunctive decision making rules and more to compromising and simplistic heurists. This finding is compatible with findings in Olsen and Swait (1998) and Huber and Pinnell (1994a and 1994b).

The results from this particular study may also have some broader implications for the design of choice experiment studies. First, amounting evidence from this and other studies suggest that, contrary to the implicit assumption made in many CE studies, the choice of the format of the opt-out alternative does matter. Both choice shares and attribute weights have consistently been found to be affected. Secondly, the findings from the study presented here and the conclusions reached by Banzhaf *et al.* (2001) and Olsen and Swait (1998) seem to suggest that the 'own brand' format provides a 'better fit' to the data than the more frequently used 'no-purchase' format. Moreover, this result seems to be confirmed for goods with different price and income elasticises, with different degrees of substitutes, and with different purchasing frequencies (e.g. recreation sites, eggs, orange juice). This suggests that the own-brand alternative may be suitable for more cases than initially thought. This may be attributed to the fact that in most choice situations the no-purchase format would be perceived as entailing an unrealistic, contrived or forced choice which causes individuals to adopt different decision making rules than they would have if faced with a more free and realistic choice. Also, using the no-purchase format conceals and looses potentially important information as to what exactly individuals prefer when they choose to opt-out. The study presented here has shown that we can include such information by directly modelling the characteristics of one's favourite brand in the estimation processes.

Ultimately the choice over the format of the opt-out alternative in CE studies should aim at enhancing the realism of the exercise and at capturing as much information as possible about the preferences of the respondents. Accumulating evidence suggests that this can be best achieved by using the own-brand opt-out format, at least in studies where respondents have a high level of familiarity with the good. This would seem to include most consumer good, recreational and health studies as well as studies concerning a broad range of mixed

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need expressed by many leading valuation practitioners to pursue a multidisciplinary approach (e.g. Bateman and local public goods (e.g. waste disposal, recycling, water treatment, local day care centres etc.). Exceptions to this recommendation may perhaps include choice situations in which the individual is not familiar with an own brand option such as in the case of the purchase of durable goods or choices over pure public goods. Yet, even in these cases, a design format that uses the 'choose another alternative option' and that collects and models the data from the characteristics of this alternative may still outperform a design that uses a no-choice format. The generality of these conclusions still need to be further explored with similar comparative studies involving choices over public goods.

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and Willis, 2000; Hanley, 1998; Mitchell and Carson, 1995).

2.12. Appendix 1 - Tables and Figures

Table 2.1 Description of four choice set versions

		OPTION A					OPTION B					OPTION C				
		LIVING	PEST	GM	Info	Price	LIVING	PEST	GM	Info	Price	LIVING	PEST	GM	Info	Price
1	Q1	Free Range	Use	30	Yes	98	Free Range	No Use	5	No	98	Free Range	No Use	0	Yes	136
2	Q2	Cage	No Use	0	No	128	Cage	No Use	30	No	68	Free Range	No Use	0	Yes	136
3	Q3	Cage	No Use	5	No	68	Free Range	Use	1	No	128	Free Range	No Use	0	Yes	136
4	Q4	Cage	No Use	30	No	128	Free Range	Use	30	No	128	Free Range	No Use	0	Yes	136
5	Q5	Cage	No Use	1	Yes	68	Free Range	Use	1	No	98	Free Range	No Use	0	Yes	136
6	Q6	Cage	No Use	1	No	98	Cage	Use	5	No	68	Free Range	No Use	0	Yes	136
7	Q7	Free Range	Use	0	No	98	Free Range	Use	1	Yes	38	Free Range	No Use	0	Yes	136
8	Q8	Free Range	No Use	5	Yes	38	Free Range	Use	1	Yes	68	Free Range	No Use	0	Yes	136
9	Q1	Free Range	No Use	1	No	38	Free Range	No Use	0	Yes	68	Free Range	Use	5	Yes	78
10	Q2	Cage	No Use	0	Yes	38	Free Range	No Use	0	No	98	Free Range	Use	5	Yes	78
11	Q3	Free Range	Use	30	No	68	Cage	No Use	1	No	68	Free Range	Use	5	Yes	78
12	Q4	Cage	Use	5	Yes	68	Cage	No Use	30	No	38	Free Range	Use	5	Yes	78
13	Q5	Cage	No Use	5	Yes	98	Cage	No Use	1	Yes	128	Free Range	Use	5	Yes	78
14	Q6	Free Range	Use	0	Yes	68	Free Range	No Use	5	No	128	Free Range	Use	5	Yes	78
15	Q7	Cage	Use	1	Yes	98	Free Range	Use	30	Yes	68	Free Range	Use	5	Yes	78
16	Q8	Cage	Use	0	Yes	128	Free Range	No Use	5	Yes	68	Free Range	Use	5	Yes	78
17	Q1	Cage	No Use	30	No	38	Free Range	Use	30	Yes	38	Cage	Use	5	Yes	78
18	Q2	Free Range	Use	1	Yes	38	Cage	No Use	30	Yes	128	Cage	Use	5	Yes	78
19	Q3	Free Range	No Use	0	No	68	Free Range	No Use	30	Yes	38	Cage	Use	5	Yes	78
20	Q4	Free Range	No Use	30	No	98	Cage	No Use	30	Yes	98	Cage	Use	5	Yes	78
21	Q5	Free Range	No Use	1	Yes	128	Cage	No Use	1	No	38	Cage	Use	5	Yes	78
22	Q6	Free Range	Use	1	No	128	Free Range	No Use	5	Yes	38	Cage	Use	5	Yes	78
23	Q7	Free Range	Use	5	No	38	Cage	Use	0	No	68	Cage	Use	5	Yes	78
24	Q8	Free Range	Use	5	Yes	128	Free Range	Use	30	No	98	Cage	Use	5	Yes	78
25	Q1	Cage	Use	0	No	38	Cage	No Use	1	Yes	98	Free Range	Use	5	Yes	78
26	Q2	Free Range	No Use	0	Yes	98	Cage	Use	0	No	38	Free Range	Use	5	Yes	78
27	Q3	Free Range	No Use	5	No	128	Cage	Use	5	Yes	98	Free Range	Use	5	Yes	78
28	Q4	Cage	No Use	30	Yes	128	Cage	Use	0	Yes	128	Free Range	Use	5	Yes	78
29	Q5	Cage	Use	1	No	68	Cage	Use	0	Yes	98	Free Range	Use	5	Yes	78
30	Q6	Cage	Use	5	No	98	Free Range	No Use	0	No	128	Free Range	Use	5	Yes	78
31	Q7	Cage	Use	30	Yes	38	Cage	Use	5	No	38	Free Range	Use	5	Yes	78
32	Q8	Free Range	No Use	30	Yes	68	Cage	Use	5	Yes	128	Free Range	Use	5	Yes	78

Table 2.2 Sampling strategy

Location	Total number of PSUs in location*	Related weight from PSUs	Population**	Relative weight from population	Total relative weight	Randomly selected number of PSUs	Number of Households selected
	A	B=A/Total A	C	D=C/Total C	E=(B+D)/2	C	D=C*25
Aberystwyth	43	0.10	61109	0.02	0.064	4	100
Birmingham	75	0.18	1013400	0.40	0.291	22	550
Cardiff	56	0.13	268934	0.11	0.120	10	250
Dorset	23	0.06	692540	0.27	0.165	14	350
Aberdeen	38	0.09	212650	0.08	0.088	6	150
Inverness	60	0.14	208700	0.08	0.113	10	250
Nottingham	123	0.29	63000	0.02	0.160	14	350
Total	418	1	2,520,333	1	1	80	2000

Notes:

**Source: UK-Info Disk 2001.05 Pro CD ROM and http://freepages.education.rootsweb.com/~wakefield/postcodes/b.html*

***Source UK National Statistics: http// www.statsbase.gov.uk/*

Table 2.3 Socio-economic characteristics across treatments

	No purchase treatment	Own Brand Treatment	Euro-Barometer
Sex			-
Non Response (%)	2.24	2.22	
Female	41.03	37.04	
Male	56.73	60.74	
Age			-
Non-response (%)	1.6	1.48	
18-24	3.21	5.19	
25-34	7.05	10	
35-44	24.36	19.63	
45-54	16.35	16.3	
55-64	19.55	21.11	
65-74	13.78	17.04	
75-84	11.22	7.04	
85-94	2.24	1.85	
95+	0.64	0.37	
Household Members			-
Mean	2.53	2.58	
St. Deviation	1.41	1.48	
Number of children			-
Mean	0.61	0.58	
St. Deviation	1.16	.92	
Education			-
Non-Response (%)	5.45	2.96	
Primary School (up to 10 years)	1.92	3.33	
Secondary School (up o 16 years)	29.81	28.52	
Upper Secondary School (up to 18 years)	14.1	16.67	
Professional qualification	29.49	26.67	
University degree	19.23	21.85	
Household income (in £)			-
Mean	3066	2686	
St. Deviation	3373	2912	
Median	2000	1750	
Non-Response (%)	7.26	8.48	
Attitudes towards GM foods*			-
How willing would your household be to buy GM foods?	3.51	3.61	-
If they were cheaper than Non-GM foods	3.22	3.23	
If they were sold at the same price as regular foods but were much more nutritious or contained more vitamins	2.98	3.06	-
If they were sold at the same price as regular foods but were produced with less pesticides and artificial fertilisers	3.14	3.23	-
If they were sold at the same price as regular foods but tasted better	3.51	3.6	-
Of all the risks we have to face at the moment, that of food safety is rather insignificant	3.57	3.39	3.50
If a majority of people were in favour of GM food, it should be permitted	3.44	3.50	3.40
Even if GM food has advantages, it is basically against nature	3.33	3.25	2.50
Whatever the risks involved in GM food, we can avoid them if we really want to	3.11	3.00	3.00
If something went wrong with GM food, it would be a global disaster	3.28	3.21	2.80

*Notes: *Answered on a 1-5 Likert scale. Average values reported.*

Table 2.4 Comparison of revealed egg consumption data obtained from sample with UK egg consumption figures

	No purchase treatment	Own Brand Treatment	UK Data *
Box Size usually purchased (%)			
Box of 6	56.09	54.44	-
Box of 10	5.13	7.41	-
Box of 12	21.15	19.63	-
Box of 15	5.13	7.04	-
Box of 18	3.53	3.7	-
Box of 24	5.12	3.71	-
Type of eggs usually purchased (%)			
Battery Cage	52.19	58.03	72
Free range	27.75	23.9	23
Organic	20.11	18.15	5
Egg size usually consumed (%)			
Small	3.02	2.73	-
Medium	40.6	39.45	-
Large	49.33	53.52	-
Very Large	7.05	4.3	-
Number of eggs consumption (weekly per household)			
Mean	7.13	7.50	7.15
St. Deviation	4.68	5.54	-
Median	6	6	-
Price (box of 6 medium eggs in Pence)			
Battery cage eggs	45	42	39
Free rang	79	76	84
Organic	129	119	125
Eggs usually purchased at (%):			
Major supermarket chains	68.75	73.88	74.8
Other (farmers, butcher, milkmen etc)	31.25	26.12	25.2

* Sources DEFRA and TNS from *http://www.britegg.co.uk/*

Table 2.5 Choice shares and response patterns across treatments

	Responses to eight choice set question								
Responses for No Purchase treatment	**Q1 %**	**Q2 %**	**Q3 %**	**Q4 %**	**Q5 %**	**Q6 %**	**Q7 %**	**Q8 %**	**TOTAL %**
Non-response	8.75	5.37	9.68	16.67	16.98	17.63	17.25	14.02	13.58
Option A	9.29	24.36	16.99	8.33	9.94	8.33	12.18	7.37	12.10
Option B	31.73	16.03	12.50	8.01	11.54	15.06	10.90	13.14	14.86
Option C	33.56	34.69	33.59	29.81	28.21	28.53	26.98	32.78	32.68
No Purchase	16.67	19.55	27.24	37.18	33.33	30.45	32.69	32.69	26.78
	100%	100%	100%	100%	100%	100%	100%	100%	100%

Responses for Own Brand Treatment	**Q1 %**	**Q2 %**	**Q3 %**	**Q4 %**	**Q5 %**	**Q6 %**	**Q7 %**	**Q8 %**	**TOTAL %**
Non-response	11.18	16.15	11.32	13.34	17.04	10.58	12.97	15.51	12.45
Option A	7.04	15.63	14.44	5.56	6.3	8.15	10.26	7.12	10.09
Option B	28.52	13.7	10.23	4.81	6.3	18.63	10.73	8.125	12.56
Option C	16.59	17.11	16.23	21.85	19.25	15.23	17.26	19.59	17.49
Own Brand	36.67	37.41	47.78	54.44	51.11	47.41	48.69	49.98	47.41
	100%	100%	100%	100%	100%	100%	100%	100%	100%

Table 2.6 Response patters in *each* of the eight choice questions

	No Purchase treatment	**Own Brand Treatment**
	%	%
Individual responded with A's in all eight CE questions	0.00	0.00
Individual responded with B's in all eight CE questions	0.64	0.00
Individual responded with C's in all eight CE questions	14.78	8.15
Individual responded with D's in all eight CE questions	6.41	22.59
Individual responded with all non-responses (blanks)	6.41	6.67

**Excluding those with all A's or Bs or C's*

Table 2.7 Choice shares across version with different specification for the fixed alternative C

Responses for No Purchase treatment	C is high quality/price brand %	C brand is generic %	C is generic brand and contains "Free range" %	C is generic brand and contains "cage" %
Non-response	13.78	17.35	14.37	20.83
Option A	8.65	10.82	10.73	22.74
Option B	17.99	7.46	22.41	15.10
Option C	45.16	34.89	31.23	9.55
No Purchase	14.42	29.48	21.26	31.77
	100%	100%	100%	100%

Responses for Own Brand Treatment	C is high quality/price brand %	C is generic brand %	C is generic brand and contains "Free range" %	C is generic brand and contains "cage" %
Non-response	12.14	14.57	13.75	15.52
Option A	6.25	10.45	9.50	18.95
Option B	15.47	7.21	17.25	12.30
Option C	29.23	18.54	23.25	8.67
Own Brand	36.91	49.23	36.25	44.56
	100%	100%	100%	100%

Table 2.8 Description of attributes and levels

Living Conditions	Living condition of hens: free range (1) Vs cage (-1)
Pesticides	Use of pesticides in chicken feed: no use (1) Vs use (-1)
Information	Quality Information/Certification on box: included (1) Vs not included (1)
GM content	GM content in chicken feed: 0%, 5%, 1% and 30%
PRICE	Price of box of six medium eggs: £0.38, £0.68, £0.98, and £1.28
ASC	Alternative specific constant such that ASC=1 if individual chose A, B, or C and ASC=0 if individual chose D

Table 2.9 Random parameter logit models for each treatment

	No Purchase treatment				Own Brand Treatment			
Variable	Coefficient	Standard Error	t-stat	P-Value	Coefficient	Standard Error	t-stat	P-Value
	Random parameters in utility functions							
Living Conditions	0.4812	0.1467	3.2812	0.0010	0.5046	0.1361	3.7067	0.0002
Pesticides	-0.0731	0.1375	-0.5314	0.5951	0.4877	0.1293	3.7726	0.0002
Information	-0.0347	0.1305	-0.2655	0.7906	-0.0504	0.1269	-0.3976	0.6909
GM content	-0.0204	0.0048	-4.2658	0.0000	-0.0113	0.0043	-2.6410	0.0083
	Non-random main effects parameters in utility function							
ASC	0.1822	0.1558	1.1691	0.2424	-0.9481	0.1031	-9.1993	0.0000
PRICE	-0.9392	0.1731	-5.4261	0.0000	-0.5759	0.1555	-3.7036	0.0002
	Non-random two-way interaction parameters in utility function							
(LC)*(Pest)	0.0096	0.0529	0.1810	0.8564	0.0005	0.0522	0.0096	0.9923
(LC)*(GMcont)	-0.0039	0.0050	-0.7778	0.4367	-0.0095	0.0033	-2.8470	0.0044
(LC)*(Inform)	0.0812	0.0711	1.1415	0.0956	0.1219	0.0461	2.6429	0.0082
(LC)*(Price)	0.2611	0.2686	0.9720	0.1215	0.1991	0.1113	1.7891	0.2671
(Pest)*(GMcont)	-0.0088	0.0045	-1.9407	0.0523	-0.0312	0.0042	-7.4292	0.0000
(Pest)*(Inform)	0.0332	0.0424	0.7836	0.4333	-0.0165	0.0501	-0.3292	0.7420
(Pest)*(Price)	0.5594	0.1405	3.9821	0.0001	0.1954	0.0991	1.9711	0.2455
(GMcont)*(Inform)	-0.0108	0.0040	-2.7231	0.0065	-0.0067	0.0034	-2.0041	0.0451
(GMcont)*(Price)	0.2037	0.1413	1.4421	0.1378	0.2317	0.1133	2.0442	0.0823
(Inform)*(Price)	0.0096	0.0529	0.1810	0.8564	0.0005	0.0522	0.0096	0.9923
	Derived standard deviations of parameter distributions							
S_LC	0.0078	0.0374	0.2093	0.8342	0.0004	0.0381	0.0102	0.9918
S_PEST	0.0061	0.0353	0.1731	0.8625	0.0066	0.0330	0.2014	0.8404
S_IMFORM	0.0011	0.0340	0.0325	0.9740	0.0049	0.0316	0.1545	0.8772
S_NONGM	0.0003	0.0034	0.0812	0.9353	0.0004	0.0021	0.1947	0.8456
S_GMCONT	0.0078	0.0374	0.2093	0.8342	0.0004	0.0381	0.0102	0.9918
Log-Likelihood	-2101.241				-1683.844			
McFadden's pseudo R^2	0.13205				0.22349			
Madalla's pseudo R^2	0.2668				0.46923			
Chi-square statistic	657.8655				932.5981			
Replications for simulated probabilities	500				500			
Sample Size	1753				1551			

Notes: Sample size is determined by number of questionnaires times number of choice occasion responses.

Table 2.10 Comparison of rescaled random parameter coefficients.

	No choice treatment (1)	Own brand treatment (2)	Difference (2)-(1)	$\lvert t \rvert$ -ratio of difference
Living Conditions	0.5123	0.8762	0.3638	3.786***
Pesticides	-0.0778	0.8470	0.9248	4.235***
Information	-0.0369	-0.0876	-0.0507	0.25
GM content	-0.0217	-0.0196	0.0021	0.012
ASC	0.1939	-1.6464	-1.8403	3.69***
Price	-1.0000	-1.0000	0.0000	-

Notes: coefficients were scaled by: -(attribute/price)
*** significant at 1% level
** significant at 5% level
* significant at 10% level

2.13. Appendix 2 – Questionnaire and survey material[71]

UCL C|S|E|R|G|E

Consumer Food Survey: Genetically Modified Products

Thank you in advance for completing this questionnaire

YOUR ANSWERS WILL BE TREATED IN THE STRICTEST CONFIDENCE

HOW TO COMPLETE THIS QUESTIONNAIRE

Most questions simply require a tick in the appropriate box ❑ to indicate your answers.

There are a few questions that require a short written answer in the space provided. The majority of questions ask you to circle the appropriate number in order of preference: **1 2 3 4 5**

Food purchasing

In this section we would like some information about your purchasing habits and your views on genetically modified (GM) Foods.

Q1 Please tick the first and second most important of the following food characteristics:

	Taste	*Price*	*Nutrition*	*Safety*
First	❑1	❑2	❑3	❑4
Seco nd	❑1	❑2	❑3	❑4

Q2 What is your approximate weekly expenditure on food at the grocery store/supermarket?

I spend roughly £ ☐ **per week on food**

Q3 How ***willing*** would your household be to buy GM foods? Please rate each one from 1- 5, where 1 is ***not willing at all*** and 5 is ***very willing***.

Not willing at all *Very willing*

1 2 3 4 5

If they were cheaper than Non-GM foods

1 2 3 4 5

If they were sold at the same price as regular foods but were much more nutritious or contained more vitamins

1 2 3 4 5

If they were sold at the same price as regular foods but were produced with less pesticides and artificial fertilisers

1 2 3 4 5

If they were sold at the same price as regular foods but tasted better

1 2 3 4 5

[71] The final questionnaire was printed on A5 appear and hence it had a different layout than the one presented here .

Egg purchasing

To better understanding your views on GM foods we will focus on asking you questions about one commonly purchased food, namely eggs.

Currently, not all chicken feed is separated into GM and Non-GM and not all egg boxes clearly state their GM content.

This means that unless the eggs we buy are labelled as *Non-GM* or *Organic*, we may in fact be consuming eggs that come from hens that have been fed with GM crops.

Q4 What effect do you think eating eggs has to your health? Please rate from 1-5, where 1 is ***very bad*** and 5 is ***very beneficial***.

Very bad ***Very beneficial***

.....1...........2...........3...........4............5

Q5 Which store/supermarket do you usually buy eggs?

Please *tick only one.*

- ❑1 **TESCO**
- ❑2 **SAINSBURY**
- ❑3 **SAFEWAY**
- ❑4 **WAITROSE**
- ❑5 **CO-OP**
- ❑6 **MARKS & SPENCER**
- ❑7 **ASDA**
- ❑8 **ICELAND**
- ❑9 **SOMERFIELD**
- ❑10 **Other** ....

Q6 What ***size box*** of eggs do you usually buy?

- ❑1 **6 eggs box**
- ❑2 **10 eggs box**
- ❑3 **12 eggs box**
- ❑4 **15 eggs box**
- ❑5 **18 eggs box**
- ❑6 **Other** ....

Q7 What ***size of eggs*** do you usually buy?

- ❑1 **Small or Mix**
- ❑2 **Medium**
- ❑3 **Large**
- ❑4 **Very Large**

Q8 How ***often*** do you buy eggs with the following characteristics?

	Never	*Not often*	*50-50 chance*	*Very often*	*Always*	*Don't know*
	1	**2**	**3**	**4**	**5**	**99**
Free Range	**1**	**2**	**3**	**4**	**5**	**99**
Barn	**1**	**2**	**3**	**4**	**5**	**99**
Organic	**1**	**2**	**3**	**4**	**5**	**99**
Non-GM	**1**	**2**	**3**	**4**	**5**	**99**
Eggs with detailed information or certification of their animal welfare and quality standards	**1**	**2**	**3**	**4**	**5**	**99**

Q9 What is the average price of the box you typically buy?

- ❑1 **£0.30-£0.49**
- ❑2 **£0.50-£0.69**
- ❑3 **£0.70-£0.89**
- ❑4 **£0.90-£1.09**
- ❑5 **£1.10-£1.29**
- ❑6 **£1.30-£1.49**
- ❑7 **£1.50-£1.69**
- ❑8 **£1.70-£1.89**
- ❑9 **£1.90-£2.09**
- ❑10 **£2.10-£2.29**
- ❑11 **£2.30-£2.59**
- ❑12 **£2.60+**

Q10 How many eggs does your household usually consume per week?

[   ] **eggs per week**

Imaginary Shopping

We would like you to consider your usual visit to the grocery store/supermarket intended to buy eggs. In such a shopping trip we are faced with various brands of eggs that differ in quality, price, animal welfare and health standards.

Similarly, in the questions below we would like you to compare the brand of eggs you typically buy against other options we will be describing to you. Each brand of eggs differs in some or all of the following characteristics.

Living conditions: This refers to the living conditions or animal welfare standards provided to each hen, e.g., *free-range hens or hens raised in usual 'battery' cages.*

Pesticides: This refers to the amount of artificial pesticides and fertilisers used in the production of the crops fed to hens. These amounts may vary across brands, e.g., *used or non-used.*

GM content: This refers to the amount (percentage) of GM content in chicken feed. This percentage may differ across brands, e.g., *Non-GM diet (0% GM content in the chicken feed).*

Information: This refers to whether a box of eggs contains information or certification on quality, living conditions, safety and nutrition.

Price: This represents the total amount of money that you would have to spend to buy a box of **6 *Medium*** sized eggs, e.g., *for £0.89.*

The imaginary shopping trip for eggs is presented directly below from Q16 to Q23. The table presents ***different brands*** *of* ***Medium*** *sized eggs and describes* ***THREE STEPS*** *to choosing your preferred brand.*

Step1: *Compare the features offered by each option of eggs.*

Q 16

	Option A	Option B	Option C	Option D
Living conditions	Cage	Free Range	Cage	I would buy my usual brand of eggs
Pesticides	No Use	Use	Use	
GM content	30%	30%	0%	
Information	Yes	Yes	Yes	
Price of 6 eggs	£0.38	£0.38	£0.78	
✓one of these	❑1	❑2	❑3	❑4
How many eggs do you consume weekly	Eggs	Eggs	Eggs	

Step2: *Tick which option you would choose*

Step3: *write how many eggs of your selected option you*

Note: the above choice set referred to the own brand version. The no purchase version only differed in the format/wording of the opt-out alternative ("I would not buy any eggs"). Also, respondents received a total of eight such choice sets.

Environmental Concerns

Q25 Please indicate your strength of agreement or disagreement for each of the following statements from 1– 5, where 1 means ***strongly agree*** and 5 means ***strongly disagree***.

Strongly agree ***Strongly disagree***

1 2 3 4 5

The earth is like a spaceship with very limited room and resources

1 2 3 4 5

The balance of nature is very delicate and easily upset

1 2 3 4 5

The so-called 'ecological crisis' facing human kind has been greatly exaggerated

1 2 3 4 5

The welfare of animals produced for human consumption is as good as can be expected

1 2 3 4 5

I am satisfied that the additives in food today are not harmful to my health

1 2 3 4 5

Restaurants do not take enough care when handling foods

1 2 3 4 5

Of all the risks we have to face at the moment, that of food safety is rather insignificant

1 2 3 4 5

The use of GM in food production offers a solution for the world food problem

1 2 3 4 5

Government should spend more money on increasing food safety

1 2 3 4 5

Humans have the right to modify the natural environment to suit their needs

1 2 3 4 5

If a majority of people were in favour of GM food, it should be permitted

1 2 3 4 5

Even if GM food has advantages, it is basically against nature

1 2 3 4 5

GM technology should not be used even for medicinal purposes

1 2 3 4 5

Information about food safety and nutrition on food labels can be trusted

1 2 3 4 5

The public can avoid eating GM foods if they want to

1 2 3 4 5

Whatever the risks involved in GM food, we can avoid them if we really want to

1 2 3 4 5

If something went wrong with GM food, it would be a global disaster

1 2 3 4 5

Any adverse effects from GM foods are only likely to emerge in the distant future

1 2 3 4 5

The government carefully monitors the correct use of GM in the medical, agricultural and food sectors

1 2 3 4 5

Scientists are responsible when working with GM technology

1 2 3 4 5

Producers of GM crops take potentially harmful consequences to human health and the environment into account

1 2 3 4 5

Information about food safety and nutrition on food labels can be trusted

1 2 3 4 5

Humans are severely abusing the environment

1 2 3 4 5

When humans interfere with nature, it often produces disastrous consequences

1 2 3 4 5

Background Information

It would help us even further if you would tell us something about your self, so that we can see if we have interviewed a broad range of people. This information will remain strictly anonymous and confidential and will be used for statistical analysis only.

Q26 Your sex

❑1 **Male** ❑2 **Female**

Q27 Your age ___________

Q28 How many people are there in your household, including yourself?

Q29 Of them, how many are 16 years of age or younger?

Q30 What are the *first four* digits of your post-code?

❑❑❑❑

Q31 How *often* does your household do the following?

Never		***Sometimes***		***Always***
1	*2*	*3*	*4*	*5*
Make a detailed shopping list before going grocery shopping				
1	*2*	*3*	*4*	*5*
Use coupons or special offers when buying food				
1	*2*	*3*	*4*	*5*
Buy organic food				
1	*2*	*3*	*4*	*5*
Eat fast foods or ready-made meals				
1	*2*	*3*	*4*	*5*
Take dietary supplements				
1	*2*	*3*	*4*	*5*
Look at the labels on food packaging for information on nutrition and ingredients				
1	*2*	*3*	*4*	*5*
Look at the labels on food packaging for information on food safety				
1	*2*	*3*	*4*	*5*
Use coupons or special offers when buying food				
1	*2*	*3*	*4*	*5*
Stock up on food items when they are on sale				
1	*2*	*3*	*4*	*5*
Go to many stores to search for the best bargain when going grocery shopping				
1	*2*	*3*	*4*	*5*

Q32 Which of these educational levels have you completed?

- ☐1 **Primary School (up to 10 years)**
- ☐2 **Secondary School (up o 16 years)**
- ☐3 **Upper Secondary School (up to 18 years)**
- ☐4 **Professional qualification**
- ☐5 **University degree**

Q33 Please indicate which income group best approximates your household income before tax.

Per month	(Per year)	**Per month**	(Per year)
☐1 **Up to £499**	(Up to £5,999)	☐8 **£3,500 - £3,999**	(£42,000-)
☐2 **£500 - £999**	(£6,000-)	☐9 **£4,000 - £4,499**	(£48,000-)
☐3 **£1,000 - £1,499**	(£12,000-)	☐10 **£4,500 - £4,999**	(£54,000-)
☐4 **£1,500 - £1,999**	(£18,000-)	☐11 **£5,000 - £6,999**	(£60,000-)
☐5 **£2,000 - £2,499**	(£24,000-)	☐12 **£7,000 - £8,999**	(£84,000-)
☐6 **£2,500 - £2,999**	(£30,000-)	☐13 **£9,000-£14,499**	(£108,000-)
☐7 **£3,000 - £3,499**	(£36,000-)	☐14 **Over £15,000**	(Over £180,000-)

Simply post your completed survey in the freepost envelope and separately post your confirmation postcard (no stamp needed) and have a chance of winning a

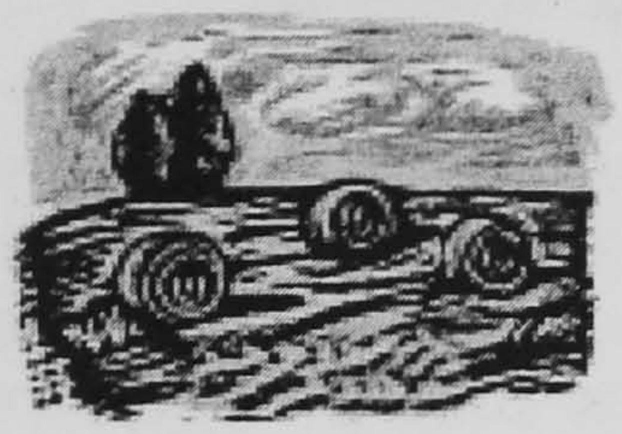
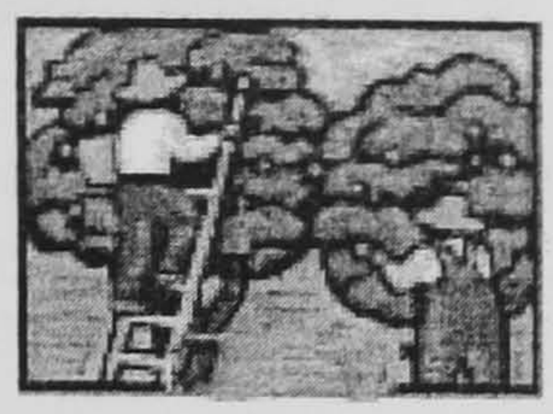
GIFT VOUCHER WORTH £50

Enter date ___/___/___(dd/mm/yy)

The Possible Positive and Negative Sides of GM Foods

Genetically Modified (GM) foods come from crops whose DNA has been modified. This DNA modification usually involves the transfer of genes between species in order to create a 'better' plant or animal species.

Genetic engineering even allows the transfer of genes from animals to plants and vice versa. The first genetically modified plants were produced in 1983 and the first modified whole food entered the market in 1994.


PERCEIVED POSITIVE SIDE OF GM FOODS

The nutrition in food can be improved: This means that

- *GM foods may have more vitamins and minerals.*
- *GM foods may benefit undernourished people in poor countries.*

Food may contain less fat

- *For example, GM potatoes may absorb less oil.*

Food may become come more tasty

- *For example, GM strawberries may be much tastier than regular strawberries.*

Farmers may have higher yields: *This means that*

- *The cost of GM-foods may be lower.*
- *More food may reach people in poor countries.*

Less pesticides required to grow crops:

- *This means that food safety and the environment may be improved.*

(i) More profits for farmers and agriculture industry

- *Food variety will increase since genetic engineering offers endless possibilities for new crops*

Concerns about food safety and health. *This means that cultivating and consuming GM crops may imply*

- *risk of developing new allergies.*
- *risk of developing resistance to antibiotics.*
- *risk of new viruses and mutations.*
- *risk of creation of 'super-weeds' that can't be easily controlled.*
- *risk that genetically modified species will prevail over non-GM species. This may lead to the extinction of non-GM species.*
- *Some people believe the growing GM crops are ethically wrong because humans are "Playing God".*

Food taste may become worse

- *For example, GM strawberries may loose their flavour or taste differently from non-GM strawberries.*

Food variety may decrease since all food may become uniform

- For example, all varieties of apples may look and taste the same.

We would be interested to have any additional comments you may have about this survey and GM foods.

Please use the space below.

C|S|E|R|G|E

CSERGE
University College London
Gower Street • London • WC1E 6BT
(44) 020-7679-5233 • Fax: (44) 020-7916-2772
E-Mail: cserge@ucl.ac.uk

Gift voucher post-card

WIN a **£50 gift voucher**

Your answers to this survey will be anonymous since there is no name or identification number on the questionnaire. After you return your questionnaire to us, please send separately this positive-card. That will tell us that you don't need any further reminders and at the same time you will be maintaining your anonymity. Your name will be included in a lottery with the chance of winning **£50 gift voucher***. Thank you for your co-operation.

Name ____

Address ______________________________________

Postcode ___________________

Please tick the box ❑ if you would like us to send you the results of this study.

❑❑❑❑ (FOR OFFICE USE ONLY)

*One in every 100 participants is a winner! Winners will be notified by CSERGE administration by the 20th of December 2001

Cover letter for first wave:

Dear Friend,

I am pleased to inform you that your household has been selected to participate in a national study that seeks to obtain ***people's opinions on genetically modified foods***.

In the past few years there has been considerable discussion about food safety in general and about genetically modified (GM) foods in particular. GM foods come from crops whose DNA has been modified. Both the public authorities and consumers have been concerned with the possible consequences (both positive and negative) of GM foods on food safety, taste, and nutrition as well as on human health and on the environment. The UK parliament along with all local governments are currently reconsidering the nation's policy on whether to allow such foods to be sold in this country. ***Hence, it is very important that the public's views and concerns about such foods are made known to the authorities before they make any decisions.***

The aim of the study is exactly, this, namely to inform the government on people's opinions about GM foods. This study is conducted by the Centre for Social and Economic Research on the Global Environment (CSERGE). The centre is an independent institution based in the University College London and is the UK's leading research centre on environmental and health issues.

Your household is one of a small number in which people are being asked to express their views on GM foods. It was drawn as part of a random sample of the entire country. ***By completing and returning this survey you have the chance to voice your opinion about the use of GM foods***. In order that the results will truly represent the thinking of the UK people, it is important that each questionnaire be completed and returned. We would like the questionnaire to be completed by the member of your household that usually does the grocery shopping. Please use the self-addressed envelope included in this pack to return the completed questionnaire. No return postage is required.

You may be assured of **complete anonymity** and **confidentiality** since your name and address are not to be put on the questionnaire or the return envelope.

Together with this questionnaire we have included a **gift-pen** as a small token of our appreciation. We have also included a post-card which allows you to participate in a lottery to win a **gift voucher worth £50.** To participate in this draw simply complete the details on the post-card and post it separately from the questionnaire (no return postage or envelope required). That will tell us that you don't need any further reminders and at the same time you will be maintaining your anonymity. You may also indicate on the post-card if you would like us to send you the results of this national study.

Please try to **respond within the next week** so we won't have to send you any reminders.

I would be most happy to answer any questions you might have. My contact details are provided below.

Thank you for your assistance.

Yours sincerely,

Professor David W. Pearce, O.B.E, D.Sc, M.A., PhD.
Project Director

Reminder letter:

Dear Friend,

Last week a questionnaire seeking your opinion genetically modified (GM) foods was mailed to you. Your name was drawn in random from a random sample of households in the UK. If you have already completed and returned it to us please accept our sincere thanks. If not, please do so today. Because it has been sent to only a small, but representative, sample of UK households it is extremely important that yours also be included in the study if the results are to accurately represent the opinions of the UK public. We would like the questionnaire to be completed by the member of your household that usually does the grocery shopping.

Yours Sincerely,

Professor David W. Pearce, O.B.E, D.Sc, M.A., PhD.
Project Director

2.14. Appendix 3 - LIMDEP code developed for programming RP logit

```
READ;File=C:\***.xls
       ;Nvar=35;Nobs=8640 ;Format=xls ;Names $

?? Set up data
?? Define variables
?? Exclude missing data

      ?================================================?
      ?                      MNL Model                 ?
      ?================================================?


NLOGIT
        ;Lhs=Choice,NIJ ,ALTij
        ;Choices=opt1,opt2,opt3,opt4
        ;Model:
         U(opt1,opt2,opt3)=ASC+BLC*LC+BPEST*PEST+BGMCONT*GMCONT
                          +BIMFORM*INFORM+BPRICE*PRICE/
         U(opt4)=BLC*LC+BPEST*PEST+BGMCONT*GMCONT
                          +BIMFORM*INFORM+BPRICE*PRICE$

      ?================================================?
      ?                      RPL Model                 ?
      ?================================================?


DISCREETE CHOICE
        ;Lhs=Choice,NIJ,ALTij
        ;Choices=opt1,opt2,opt3,opt4
        ;RPL=BLC,BPEST,BIMFORM,BGMCONT
                       ? excluding ASC1,BPRICE from RM
        ;Pts=500
        ;Fcn=BLC(N),BPEST(N),BIMFORM(N),BGMCONT(N)
            ?excluding ASC1(N),BPRICE (N)

        ;Model:

        U(opt1,opt2,opt3)=ASC+BLC*LC+BPEST*PEST+BGMCONT*GMCONT
                          +BIMFORM*INFORM+BPRICE*PRICE
                          +BINT1*INT1+BINT2*INT2+BINT3*INT3
                          +BINT4*INT4+BINT5*INT5+BINT6*INT6
                          +BINT7*INT7+BINT8*INT8+BINT9*INT9/
         U(opt4)=BLC*LC+BPEST*PEST+BGMCONT*GMCONT
                          +BIMFORM*INFORM+BPRICE*PRICE
                          +BINT1*INT1+BINT2*INT2+BINT3*INT3
                          +BINT4*INT4+BINT5*INT5+BINT6*INT6
                          +BINT7*INT7+BINT8*INT8+BINT9*INT9$


STOP$
END$
```

CHAPTER THREE

Accounting for Preference Heterogeneity in Random Utility Models: An Application of the Latent Market Segmentation Model

CHAPTER THREE

Accounting for Preference Heterogeneity in Random Utility Models: An Application of the Latent Market Segmentation Model

3.1. Introduction

Discrete choice revealed and stated preference data motivated from random utility models have traditionally been analysed using the standard logistic model (McFadden, 1974 and 1999). These models provide an econometric framework that operationalise standard utility-based theory of choice, such that individual discrete decisions (recorded in either revealed and stated preference data sets) can be explained as a function of both the observed and random determinants of choice. Though the simplicity in constructing and analysing such a model has proven very useful, the behavioural restrictions it imposes on the data have increasingly troubled applied econometricians (Amemiya, 1981). One of the limiting implications of the standard model is that it imposes homogeneity with respect to individual preferences.[1] Put differently, the basic RUM assumes that the preferences and hence the utility functions of *all* individuals are characterised by the *same* observable and unobservable components. Yet, in many cases it is plausible to expect that individual preferences (tastes) are heterogeneous and vary across individuals with respect to their personal characteristics. Failing to account for preference heterogeneity, when it is warranted, leads to biased utility parameter estimates (Green 1997). Such biased estimates have been shown to produce misleading predictions of the main variables of interest such as participation probabilities, market shares as well as marginal and total welfare measures (Breffle and Morey, 2000). Hence, the unwarranted imposition of preference homogeneity ultimately undermines the policy usefulness of the results. Commonly used approaches to account for preference heterogeneity in a random utility framework have focused on variants of random and fixed effects heteroscedastic extreme value models (e.g. Swait and Adamowicz, 1996) as well as random parameter models (e.g. Train, 1998; Layton, 2000).

[1] Other econometric extensions of the standard multinomial logit model include: (i) variants of nested logit models (e.g. Hauber and Parsons, 2000) and attempts at converging multinomial Probit models to account for IIA violations (e.g. Green 1997), (ii) pooled (stacked) data models that fuse or combine stated with revealed choice data (e.g. Adamowicz *et al.*, 1997) or combine multiple attribute with dichotomous stated preference data (e.g. Englin and Cameron, 1996) in an attempt to cross validate the results from each

This chapter provides a contribution to this series of econometric developments by presenting an application of the latent segmentation model as an alternative model for accounting for preference heterogeneity in data derived from stated preference choice experiment studies. The model extends the basic RUM by accounting for the fact that, in many policy situations, there are segments of individuals that may be characterised by *common* preference functions (i.e. within segment homogeneity), but which differ *across* segments (i.e. between segment heterogeneity). The exploration of this particular type of modelling approach was motivated by recent assessments of the analysis of choice experiment data that have acknowledged the policy usefulness of accounting for preference heterogeneity at the segment level and have thus highlighted this as an area for fruitful novel research (e.g. Haab and McConnell, 2002; Adamowicz and Boxall, 2001; Adamowicz *et al.,* 2000; Louviere *et al.* 2000; Hanley, 1998).

The chapter presents the latent segmentation model that consists of *simultaneous* estimation of segment membership and choice. The model is applied to data obtained from a stated preference choice experiment study on the value of reducing the genetically modified content in the production of one commonly consumed food, namely eggs. The analysis shows that the latent market segmentation model accounts for preference heterogeneity across individuals by identifying segments of consumers that are characterised by common demographic and psychographic traits. This modelling approach is then compared to other more commonly used means of accounting for preference heterogeneity, mainly the interaction effects, random parameter logit and covariance heterogeneity models, and is shown to outperform all alternative specifications on statistical grounds. Finally, the specific application of the latent market segmentation model shows that it provides added and unique policy relevant information, and hence it outperforms rival specifications on economic and policy relevant grounds.

3.2. Accounting for preference heterogeneity: review of the literature.

More often than not empirical analysis of both stated and revealed choice data has assumed homogeneous preferences across individuals. Yet, it is reasonable to expect that preferences and tastes across individuals are inherently heterogeneous. This implies that

type/source of data, and (iii) panel logit models to account for the interdependence across multiple choice observations obtained from the same individual (e.g. Revelt and Train, 1998).

assuming that utility parameters are constant across individuals (i.e. preference homogeneity) may, in many cases, be unwarranted. Accounting for heterogeneity in taste will result in estimating unbiased parametric models of individual choice (Green, 1997). This enhances the accuracy and reliability of estimates of key economic variables such as total demand and expenditures, market share and participation as well as marginal and total welfare effects. Moreover, accounting for preference heterogeneity provides a broader picture of the distributional and other impacts of policy decisions.[2] This section reviews various attempts to accommodate heterogeneous preferences in applied econometric work.[3]

3.2.1 Accounting for preference heterogeneity in demand analysis

The analysis of standard demand and Engle curve expenditure functions from *non*-discrete revealed preference data (e.g. on expenditures on private consumption goods, durables, and recreation etc.) has accounted for preference heterogeneity with two main approaches. The earliest attempts focused on introducing socio-demographic variables in demand or expenditure functions (e.g. Pollack and Wales, 1992). More recently, attempts have used cluster analysis to stratify individuals into various clusters and then estimate demand or expenditure functions for each cluster separately (e.g. Famulari, 1995; Boxall *et al.*, 1996). In both of these approaches socio-demographic variables are used either as direct independent variables affecting choice or as variables used in the cluster analysis. Such approaches have achieved two things. Firstly, they have managed to identify *sources* or explanations of heterogeneity in that they have focused on examining which socio-economic variables and in what way affect individual tastes or stratification. Secondly, they have allowed for an enhanced testing (compared to models assuming homogeneity) of behavioural and statistical assumptions governing applied demand analysis. For example, Famulari (1995) and Boxall *et al.* (1996) using cluster analysis have shown that stratification reveals a significant improvement in the tests of consistency with the axioms of revealed preference (see Boxall and Adamowicz, 1999).[4] We now turn to the main emphasis of this chapter which is the treatment of preference heterogeneity in discrete preference data.

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[2] "Analysts may be as interested in understanding *who* would be affected by environmental quality changes in addition to determining the aggregate economic value associated with such changes". (Adamowicz and Boxall, 2001).

[3] For a more though discussion see Boxall and Adamowicz (1999), Louviere *et al.* (2000), and Breffle and Morey (2000).

[4] Recent work on accounting for preference heterogeneity in revealed preference non-discrete data has focused on non-parametric models (e.g. Blundell, 2001 and 2000; Blundell *et al.*, forthcoming 2003).

3.2.2 Accounting for preference heterogeneity in random utility models

Identifying sources of preference heterogeneity in discrete choice models as opposed to standard demand analysis is complicated by the fact that variables on individual characteristics (i.e. the sources of heterogeneity) do not vary across alternatives. To clarify this point, let us examine the basic discrete choice model framed in terms of a random utility model. The random utility model (RUM) is based on postulating the composite utility function:

$$U_{ni} = V_{ni}(X_{ni}) + \varepsilon_{ni} \qquad \text{Eq. 1}$$

Where U_{ni} is the total utility that individual n obtains from choosing the alternative i from a finite set C. It is decomposed into a systematic (deterministic) part, V_{ni}, which is a function of a vector, X_{ni}, consisting choice-specific attributes as well as individual specific characteristics, and a random part ε_{ni} which is assumed to be independent of X_{ni} and follows some predetermined distribution. Alternative i will be chosen over j if $V_{ni}(X_{ni}) + \varepsilon_{ni} > V_{nj}(X_{nj}) + \varepsilon_{nj}; \forall\ i \neq j, \forall\ j \in C$ and the probability that this is the case will be given by:

$$\pi_{in} = \Pr\{V_{ni}(X_{ni}) + \varepsilon_{ni} \geq V_{nj}(X_{nj}) + \varepsilon_{nj}; \forall\ i \neq j, \forall\ j \in C\} \qquad \text{Eq. 2}$$

By assuming a specific distribution for the error components in Eq. 2 we can construct an operational discrete choice model. Assuming a linear functional form for $V_{ni}(X_{ni})$ and that the ε_{ni} disturbances are independently and identically distributed (iid) following a Weibull distribution we can derive the basic multinomial logit model (McFadden, 1974):[5]

$$\pi_{in} = \frac{e^{\mu(\beta X_i)}}{\sum_{j \in C} e^{\mu(\beta X_j)}} \qquad \text{Eq. 3}$$

[5] This model is also referred to as the 'conditional' logit model to differentiate it from other variants. Yet such terminology is unnecessary since all such models are multinomial logit models with varying distributional assumptions for ε_{ni} and varying assumption on the nature, composition and functional form of $V_{ni}(X_{ni})$. See Amemiya (1981) and Green (1997) for a review of the multinomial logit model

Where β is a vector of parameters to be estimated and μ is a scale parameter that is usually assumed to equal 1 so that the $\beta's$ can be identified.[6] The vector β also includes a series of alternative specific constant terms (ASC_i) that capture the effects in utility from any attributes not included in X_{ni}.

The choice model in Eq. 3 assumes homogeneity of preferences which follows from the assumption that the deterministic component of the utility function is invariant across individuals (i.e. $\beta_n X_i = \beta X_i$). This further implies that the variance of the error term is assumed to be the same for all individuals and that there is no correlation across occasions for a given respondent (this implication follows from the *iid* assumption). In practical econometric terms this translates into an inability to identify and estimate the coefficients of individual characteristics in the indirect utility function since terms that do not vary across alternatives fall out of the probability (Green, 1997, p.914). Hence, even if we directly included such individual characteristics in the vector X_{ni} their effect on the probability of choosing a particular option $\pi_n(i)$ cannot be assessed. The sub-sections that follow discuss alternative approaches to account for and identify the sources of preference heterogeneity. These are conditional logit models with interacted individual characteristics, the random parameter logit models, covariance heterogeneity models and latent class models.[7]

3.2.3 Multinomial Logit with interacted individual characteristics

The most common strategy to tackle this problem has been to interact individual-specific characteristics with attributes of the choices or with the alternative specific constant(s) of the indirect utility functions. (Greene, 1997).[8] Commonly chosen individual characteristics include income[9], age and education. [10] This approach allows the $\beta's$ to vary across

[6] As μ tends to (but does not equal) zero, the probability of choosing the alternative with highest predicted utility approaches unity (i.e. the probability mass becomes concentrated in the choice with the highest systematic utility). As μ tends to infinity the probabilities of all choices tend to equality; that is, the probability distribution of choices becomes uniform. Consequently the scale parameter may be interpreted as a measure of the error or lack of precision in the subject's choices. (Muller *et al.*, 2001).

[7] See Louviere *et el* (2000) pp. 189-205 for a discussion.

[8] The rationale is to interact the individual specific variables which are invariant over alternatives with attributes or ASCs that are choice specific. A complete set of interaction terms creates a singularity so one is dropped (Green, 1997, p. 914)

[9] See McFadden (1999) and Herriges and Kling (1997) for a theoretical discussion of income effects in logit models.

individuals in a systematic way as a function of individual characteristics. The analyst can thus assess the distributional impacts of a particular policy change. Yet, the results from such models are very sensitive to the way in which the parameters and individual characteristics are interacted. Moreover, multicollinearity is often a problem with too many interactions (see Breffle and Morey, 2000). Also, to our knowledge, all of the applied discrete choice literature has avoided exploring the effects of individual variables other than demographics, such as attitudinal, motivational and perceptual variables, as sources of heterogeneity.

3.2.4 Random Parameter Logit

The random parameter logit (RPL) models allow all choice-specific parameters to vary randomly across individuals. That is, β in Eq. 3 becomes β_n. This is accomplished by assuming that β_n is drawn from a joint density function, the parameters of which (mean and standard deviation) are recovered by simulation (see Layton, 2000; Train, 1997; 1998; Bhat, 1998 and 2000; McFadden and Ruud, 1994)[12]. Recent applications of RP logit models have shown that they outperform conditional logit approaches both in terms of overall fit as well as in accuracy of welfare measure estimates. (e.g. Cicia, Del Giudice and Scarpa, 2001; Breffle and Morey, 2000; Revlet and Train, 1998; Phaneuf *et al.*, 1998; Brownstone and Train, 1999; Layton and Brown, 2000; Morey and Rossmann, 1999; Brownstone, Brunch and Train, 1998)

Some have cautioned that while the RPL model explicitly accounts for preference heterogeneity, it is not well-suited to explaining the *sources* of heterogeneity (e.g. Boxall and Adamowicz, 1999 and Adamowicz *et al.,* 1998). This can be somewhat rectified by including individual characteristics in the utility function. By doing so the RPL model will pick up two types of variation in preferences. A systematic type (i.e. preferences vary with respect to individual characteristics) and a random type (i.e. unconditional taste

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[10] For example, Morey *et al.* (2002), Scarpa *et al.* (2001), Rolfe *et al.* (2000), Adamowicz *et al.* (1997). Swallow *et al.* (1994) provide some recent examples of this approach.

[11] Some rare exceptions are Harris and Keane (1998) and Madanat *et al.* (1995)

[12] Most applications of the RP logit model assume that the random parameters are normally distributed. Other commonly used distributional assumption is the lognormal distribution. In theory any distribution may be assumed as long as the implication of this assumptions are acknowledged. For example the normal distribution allows for a positive density between minus and plus infinity, which implies that the sign of the realized parameter can vary across individuals. The log normal distribution on the other had would restrict the sign to be the same for all individuals. Which is most appropriate depends on the application.

heterogeneity).[13] The caveats mentioned above of multicollinearity among individual characteristics and of the absence of psychometric characteristics in most applied work carry over. Moreover, the selection of a particular multivariate distributional function describing the random parameters (e.g. multivariate normal) may be hard to justify (Bateman *et al.*, 2002).

3.2.5 Covariance Heterogeneity (CovHet) Models

CovHet models belong to the family of heteroscedastic extreme value (HEV) models that attempt to parameterise the scale factor, μ, in Eq. 3 with individual socio-demographic variables.[14] Recent examples include Muller *et al.* (2001) Johnson, Banzhaf and Desvousges (2000), Louviere *et al.* (2000), Cameron and Englin (1997), Swait and Adamowicz (1996) and Swait and Stacey (1996). These studies have shown that models with a parameterised scale parameter are statistically superior to models that impose the restriction of μ being equal to one. Yet, applied econometricians have questioned whether this approach, by which individual characteristics enter the model as affecting the scale parameter, is more appropriate than an alternative approach in which these variables influence tastes (i.e. utility parameter differences) (Boxall and Adamowicz, 1999). In essence, scale heterogeneity models are examining a different aspect of survey responses. Models of scale heterogeneity attempt to compare differences in respondent coherence, decision-making ability or interest in the activity (Breffle and Morey 2000).[15] Preference heterogeneity models on the other hand examine how choice attributes differ across individuals with differing characteristics. It is an empirical issue which approach to capturing preference heterogeneity is most suitable for each particular data set.

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[13] Most studies that have used the RP logit have not incorporated individual characteristics in the estimation procedure thus focusing on unconditional heterogeneity. See Morey and Rossmann (1999) and Revelt and Train (1998) for examples of applications of the RPL model with both conditional and unconditional heterogeneity. The particular applications found considerable variation remaining after including demographic variables, indicating that tastes vary considerably more than can be explained by observed individual characteristics. The implication of these studies is that including both types of heterogeneity in RPL models greatly improves the model fit.

[14] A characteristic of the HEV models is that they try to relax the iid assumption. Note that not all of the HEV models parameterise the scale parameter. For example, some models simply allow for randomness in scale (see Breffle and Morey, 2000 and Louviere *et al.*, 2000). This approach, however, does not reveal the sources of this randomness.

[15] Ongoing research tries to combine both forms of heterogeneity in one model. See Breffle and Morey (2000)

3.2.6 Latent class models

Latent class models provide another approach to identifying sources of heterogeneity in tastes using individual characteristics. These models use some form of multivariate cluster analysis of socio-demographic characteristics to reveal and determine relatively homogeneous latent segments of the sampled population. Once these homogeneous segments have been identified separate multinomial (logit) choice models can be estimated. Applications of this approach include Salomon and Ben-Akiva (1983), Gross (1995) and Fredman and Emmelin (2001). These studies have revealed that models that separately estimate coefficients for each segment were statistically superior to models which assume that the sample was drawn from a single homogeneous segment. In contrast to the RPL model, latent class approaches are quite successful at identifying sources of heterogeneity. Also, note that whereas the RPL model allows choice parameters to vary across each individual, the latent class approach assumes that these parameters vary across segments of individuals. In many cases, this property makes the latent class model more policy relevant than the RPL model. For example, the policy debate over GM foods is highly pre-occupied with discussions over the feasibility of segregating food into GM and GM-free markets. In such cases, models that account for heterogeneity at the segment and not individual level would provide more actionable, operationally meaningful and policy relevant information. [16]

Despite their appeal, a troubling aspect of the latent class models is that they assume that cluster membership depends solely on ones individual characteristics and is *independent* from one's choice decisions. It seems reasonable, however, to expect that these two decisions are not separate but somehow related. Moreover, the use of these models has been based on statistical grounds and has lacked sufficient behavioural foundations motivating their use. Most latent class models mentioned above classify individuals into clusters purely on statistical grounds and provide no behavioural foundations on which they can postulate an explicit behavioural mechanism through which the latent classes

[16] RP models may provide a more 'fine' account of preference heterogeneity, but this is a hollow victory since this information is not very useful in cases such as the GM-food debate. What policy makers need to know is the differences among segments of the population as well as the size and characteristics of these segments and not that every individual is somehow different!

emerge.[17] In addition, past applications of latent class models have mainly relied on socio-demographic and not attitudinal variables in determining the number and nature of latent classes. It is likely, however, that psychographic variables are equally (if not more) important determinants of segment membership and should be considered.

This chapter develops and presents another avenue for accounting for preference heterogeneity in RUM's, the latent segmentation (LS) model. The LS model has several affinities to the latent class approach yet differs in many important ways. Like the latent class models mentioned above, the LS model identifies sources of preference heterogeneity by revealing a finite number of latent segments of consumers that are characterized by relatively common tastes. Yet, unlike previous latent class models the LS model presented here *simultaneously* performs market segmentation and explains choice for a given segment of the population. In addition, the framework presented in this chapter for determining the sources of preference heterogeneity does not rely merely on information from socio-demographic data but also utilises the information from psychographic data. By using psychographic variables it is argued that the model attempts to satisfy the, often neglected, plea for including latent taste, attitudinal and perceptual variables in micro-econometric analysis. Most notably McFadden (1986a) has argued that:

> "... the critical constructs in modelling the cognitive decision process are *perceptions* or beliefs regarding the products, generalized *attitudes* or values, *preferences* among products, decision protocols that map preferences into choices, and *behavioural intentions* for choice" (McFadden 1986a p.276).

Hence the work presented in this chapter is related to the emerging literature on the analysis of discrete choice data that emphasises the importance of the explicit treatment of latent individual characteristics in the decision-making processes (e.g. Koppelman and Hauser, 1979; McFadden, 1986a, 1997; Ben-Akiva and Boccara, 1987; Ben-Akiva, 1992; Ben-Akiva *et al.*, 1994; Ben-Akiva *et al.*, 1997; Morikawa *et al.*, 1996.). The main outcome from this research is that the incorporation of latent attitudinal, perceptual and motivational constructs leads to a more behaviourally realistic representation of the choice process, and consequently, better explanatory power. Moreover, the same body of work has shown that psychometric data captures taste heterogeneity more adequately than demographic characteristics. This development has been followed by the stated preference literature. For example the NOAA panel have recommended the use of such variables in

[17] For example, studies such as that of Salomon and Ben-Akiva (1983) and McCutcheon (1987) have determine clusters within a specified population with smaller 'within-group' rather than 'between-group' variation. Novack *et al.* (1992) provides a review of various statistical segmentation approaches.

models of stated values in order to assess the construct validity of the results (Arrow *et al.* 1993, p.4609), while Langford *et al.* (2000) have shown that that attitudinal indexes, as opposed to socio-economic or demographic indicators, can in many cases be the primary driver of stated values. Bateman *et al.* (2002) point out that despite such findings the emphasis in many stated preference studies has been upon the latter at the expense of the former, an approach which seems unbalanced given the paucity of clear and definite expectations afforded by economic theory.

Finally, the main advantage of the LS approach presented here is that the market segments are derived not just on the basis of attitudinal and socio-economic data, but also on the basis of observed choice behaviour and the attributes of the various alternatives. This is achieved by virtue of the simultaneous nature of the estimation procedure. Such 'behaviour-based' segments are much more actionable and operationally useful to policy makers than segments obtained from other statistical or 'demographic-based' methods mentioned above.

3.3. The Latent Segment Membership Model

The LS model is related to the so-called finite-mixture models (see Titterington *et al.* 1985) frequently encountered in the marketing literature.[18] Although other approaches for accounting for preference heterogeneity have received considerable attention (see previous Section), the LS model has not been widely utilized in the micro-econometric literature (neither for the analysis of revealed nor stated discrete choice data). This may be attributed to two reasons. First, as mentioned above there has been a general neglect on behalf of many applied econometricians to acknowledge the importance and usefulness of exploring latent taste constructs. Factor analytic and psychometric techniques required for determining such variables have rarely been employed. Secondly, early versions of the LS model such as the linear logistic latent class model developed in Formann (1992), were motivated purely on statistical grounds and lacked any microeconomic behavioural underpinnings. The LS model presented here utilizes the theoretical framework developed by McFadden (1986a) that allows the researcher to postulate a behavioural mechanism for

[18] Such as the latent discriminant model presented in Dillion and Mulani (1989), the mixture logit model by Kamakura and Russell (1989), the latent-class models of Rosbergen *et al.* (1997) and Bhat *et al.* (2002). A review of mixture models is offered in Dillon and Kumar (1993). A review of the development of latent segment models in the marketing literature can be found in Wedel and DeSarbo (1994) and Allenby *et al.* (2002).

simultaneously determining segment membership and product choice as well as providing a theoretically consistent justification for incorporating latent variables into the analysis.

3.3.1 Conceptual framework of the LS model.

The underlying behavioural model of the choice process is depicted in Figure 1 of Appendix 1 that has been adapted from McFadden (1986a), Ben Akiva *et al.* (1997) and Swait (1994).

This path diagram includes both observed and unobserved (latent) variables that affect both segment membership and the realisation of choice. The shaded area of the diagram incorporates all latent variables. These include the subjective perceptions the individual has for the product attributes, the individual's preference function as well as the mental processes governing individual decisions. Moreover, the unobservable section of the diagram also includes the likelihood that a particular individual n (where $n = 1....N$) belongs to a particular class or segment s (where $s = 1...S$), the selection mechanism process by which individuals are classified into segments and the actual number of segments that characterize a particular population. In theory there can exist as many segments as individuals (i.e. $N=S$). The boxes outside the shade area refer to observable variables. These include the objective attributes of each choice alternative, the socio-demographical characteristics of the individual, the indicators of the individual's general attitudes and perceptions, the exogenous market constraints and institutional conditions that an individual faces when undertaking his/her choice and the final outcome of choice.

Following McFadden (1986a) the mechanism that leads to the realization of choice is as follows:

a) Individual latent attitudes, perception and motives (approximated by observed attitudinal indexes) together with the individual's socio-demographic traits determine his/her segment membership likelihood function.
b) Through a latent segment classification mechanism, the membership likelihood function determines the latent segment to which an individual belongs.
c) The individual's preferences over a set of choices are influenced by the latent class one belongs to as well as by one's socio-demographic traits and his/her subjective perceptions of the choice objective attributes.
d) These preferences are then processed according to a decision protocol which leads to the observance of the final choice. In random utility models this protocol is governed by some form of constrained utility maximization.

This framework allows for the inclusion of both 'objective' and 'subjective' (or perceptual) data in the analysis of individual choice. Moreover, this model of choice implies that preferences are *indirectly* affected by attitudes, perception and motives through membership in a particular latent segment. This comes into contrast with other preference heterogeneity models that imply that attitudes and perceptions directly influence preferences. More importantly, the model acknowledges that it is possible to simultaneously explain individual choices and infer latent segment membership.

3.3.2 Building the econometric model

This section attempts to operationalise the choice process described above within the random utility framework. The utility function of Eq. 1 now becomes

$$U_{ni/s} = V_{ni/s}(X_{ni/s}) + \varepsilon_{ni/s} \qquad \text{Eq. 4}$$

which gives the utility generated from the i^{th} alternative of the n^{th} individual that belongs to a particular segment s. By assuming a linear functional form for $V_{ni/s}(X_{ni/s})$ Eq. 1 becomes:

$$U_{ni/s} = \beta_s X_{in} + \varepsilon_{ni/s} \qquad \text{Eq. 5}$$

where β_s is the utility parameter vector for segment s. Within this framework preference heterogeneity implies that that each segment has its own utility vector (i.e. $\beta_s \neq \beta_k ; \forall s \neq k, \forall k \in S$). In other words, through β_s the model captures the idea that preferences and choices are affected by latent segment membership (Swait 1994). The decision protocol for a utility maximizing individual n that belongs to a segment s will be to chose alternative i if $V_{ni/s}(X_{ni/s}) + \varepsilon_{ni/s} > V_{nj/s}(X_{nj/s}) + \varepsilon_{nj/s} ; \forall\ i \neq j, \forall\ j \in C$ and the probability that this is the case will be given by:

$$\pi_{in} = \Pr ob\{V_{ni} + \varepsilon_{ni} \geq V_{nj} + \varepsilon_{nj} ; \forall\ i \neq j, \forall\ j \in C\} \qquad \text{Eq. 6}$$

And by assuming that the disturbances ε_{ni} are iid and follow a Type I (or Gumbel) distribution we can derive the probabilistic response function:

$$\pi_{n/s}(i) = \frac{e^{\mu_s(\beta_s X_{in})}}{\sum_{j \in C} e^{\mu_s(\beta_s X_{jn})}} \qquad \text{Eq. 7}$$

probabilities that an individual n belonging to a particular segment s will choose an option i.

In order to construct a segment membership function it is assumed that there exist a finite number of segments S $(S \leq N)$ in which each individual can be classified with some probability W_{ns}. The actual number of segments is itself a latent variable and will have to recovered from the estimation processes. Let Y_{ns}^* represent a latent variable that determines segment classification of all N individuals into one of the segments in S. According to the behavioural framework presented in Figure 1, Y_{ns}^* was described as being a function of both observable and unobservable (latent) individual characteristics. Following Ben-Akiva *et al.* (1997) and Swait (1994) This relationship can be formulated *via* the structural equations:

$$Y_{ns}^* = \Gamma_{ps} G_{np}^* + \Gamma_{as} G_{na}^* + \Gamma_s X_n + \zeta_{ns} \qquad \text{Eq. 8}$$

$$G_{np} = \delta_p G_{np}^* + \zeta_{np} \qquad \text{Eq. 9}$$

$$G_{na} = \delta_a G_{na}^* + \zeta_{na} \qquad \text{Eq. 10}$$

where, G_{np}^* and G_{na}^* are vectors of individual latent perceptual and attitudinal variables, G_{np} and G_{na} the vectors of observable indicators of these variables[19], X_n the vector of observable individual socio-demographic characteristics, $\Gamma_{ps}, \Gamma_{as}, \delta_p, \delta_a$ and Γ_s are the corresponding parameter vectors to be estimated and ζ_{np}, ζ_{na} and ζ_{ns} the residual terms. For brevity we can express Eq. 8 in the more succinct form:

$$Y_{ns}^* = \alpha_s Z_n + \zeta_{ns} \qquad \text{Eq. 11}$$

Where Z_n contains both the psychographic and demographic characteristics of the individual and a_s is the corresponding parameter vector. That is:

[19] For instance, if we are considering this model in the context of recreation demand examples of latent attitudinal characteristics would be the degree of one's nature appreciation, propensity towards challenges, propensity for social interaction, and propensity to avoid routine (see the study by Boxall and Adamowicz 1999). In the case of the purchase of cosmetics, examples of latent attitudinal characteristics that may affect segment membership may include one's attitudes towards fashion and beauty (see the study by Swait 1994). The corresponding observable indicators of these latent variables would be derived by factor analysing responses to a series of questions that are potentially related to the latent attitudinal/perceptual characteristics.

$$Z_n = \begin{bmatrix} G_{np} \\ G_{na} \\ X_n \end{bmatrix} \quad \text{and} \quad \alpha_s = (\Gamma_{ps}, \Gamma_{as}, \Gamma_s) \qquad \text{Eq. 12}$$

An individual will be classified in a particular segment s as opposed to any other segment $k \in S$ according to the classification mechanism:

$$Y^*_{ns} = \max\{Y^*_{nk}\}, k \neq s, k = 1,..,S \qquad \text{Eq. 13}$$

Since, Y^*_{ns} is a random variable, we can assess the probability that a particular individual belongs to a specific segment by specifying the distribution and nature of the residual terms in Eq. 11. By assuming that the ζ_{ns}'s are independent across individuals and segments as well as independent of ζ_{np} and ζ_{na}, and that they follow a Gumbel distribution with scale parameter λ we can derive the probability function for segment membership: [20]

$$W_{ns} = \frac{e^{\lambda(a_s Z_n)}}{\sum_{k=1}^{S} e^{\lambda(a_k Z_n)}} \qquad \text{Eq. 14}$$

Note that Eq. 14 is simply the multinomial logit model that determines the probability of a an event occurring only on the basis of individual specific and not choice-specific variables (Green, 1997; Schmidt and Strauss, 1975).

In order to derive a model that simultaneously accounts for choice and segment membership we bring together the two logit models of Eq. 7 and Eq. 14 to construct a

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[20] A similar distributional assumption has been made in most of the studies that have constructed segment membership function (e.g. Kamakura and Russell, 1989; Gupta and Chintagunta, 1994; Swait, 1994; Boxall and Adamowicz, 1999; Louviere *et al.*, 2000). Note one of the implications of assuming a Gumbel distribution is that the scale factor will be such that $\lambda > 0$ and $V(\zeta_{ns}) = \pi^2/6\lambda^2$. Hence, the segment - level scale parameter is inversely related to the variance of the error term of the segment membership function. This implies that as λ increases we will have a smaller variance and hence a more precise classification of individuals into latent segment. As $\lambda \rightarrow 0$ the weight $W_{ns} \rightarrow 1/S$ (where total S the total number of segments) and W_{ns} will then be the same for each segment. This means that individual assignment to the segments will be essentially random (i.e. segments are indistinguishable) (Swait, 1994, p.81).

mixed-logit model that consists of the joint probability that individual n belongs to segment s *and* chooses alternative i:

$$P_{isn} = \left(\pi_{in/s}\right)\cdot\left(W_{ns}\right) = \left[\frac{e^{\mu_s(\beta_s X_{in})}}{\sum_{j\in C} e^{\mu_s(\beta_s X_{jn})}}\right]\cdot\left[\frac{e^{\lambda(a_s Z_n)}}{\sum_{k=1}^{S} e^{\lambda(a_k Z_n)}}\right] \qquad \text{Eq. 15}$$

While the formulation of the marginal probability of an individual n in segment s choosing option i is given by:

$$P_{isn} = \sum_{s=1}^{S}\left[\frac{e^{\mu_s(\beta_s X_{in})}}{\sum_{j\in C} e^{\mu_s(\beta_s X_{jn})}}\right]\cdot\left[\frac{e^{\lambda(a_s Z_n)}}{\sum_{k=1}^{S} e^{\lambda(a_k Z_n)}}\right] \qquad \text{Eq. 16}$$

This expression contains the two types of logit formulations described above. The first corresponds to a conditional logit model that contains segment specific utility parameters. The second is the multinomial logit model that consists of segment membership parameters. It can be interpreted as a mixture model since it allows the use of both choice attribute data and individual characteristics to simultaneously explain choice behaviour and segment membership (Titterington *et al.,* 1985).

Note that if we impose the restrictions $\alpha_s = 0, \beta_s = \beta, \mu_s = \mu, \forall s$ we are in essence assuming homogeneity in tastes (i.e. the population is characterized by a single segment) and the model in Eq. 14 collapses to the standard MN logit model of Eq. 3. Alternatively, Swait (1994) points out that as $S \rightarrow N$ (i.e. the number of segments approaches the number of individuals in the sample or population) the model of Eq. 16 becomes more and more akin to the random parameter logit model discussed above. Finally, it is worth noting that we need not assume the restrictive IIA assumption for mixture models such as the type of Eq. 16 (Shownkwiler and Shaw 1997).[21]

[21] That is "the ratio of probabilities of selecting any two alternatives would contain arguments that include the systematic utilities from other alternatives in the choice set This is the result of the probabilistic nature of

3.3.3 Estimation process.

To estimate the LS model we utilize the approach of McFadden (1986a). First, we estimate the parameter vectors δ_p and δ_a using psychometric techniques.[22] Secondly, we obtained scores for the vector of observable attitudinal indexes G_{np} and G_{na}. Third, we specify the variables that determine segment membership (i.e. the variables in z_n which includes the vectors G_{np} and G_{na} as well as demographic variables) and the variables that determine choice (i.e. the variables in x_{in} which include attributes but also socio-economic characteristics). Fourth, we construct the log-likelihood function of Eq. 16 and use full information maximum likelihood methods to estimate the model for a specified value of S. We repeatedly estimate the model for several segments up until a reasonable number of segments (roughly more than 3 and less than 10). Fifth, we use statistical criteria to decide which model fits the data best which amounts to deciding on the optimal or most appropriate number of segments that the specific sample or population can be divided into. Swait (1994) points out that because of this sequential estimation processes the estimated parameters will be consistent but not efficient.[23] Finally, note that the model and estimation process presented here is applicable for N revealed or stated preference choice observations. This implies that we can use this approach even in situations where we have multiple observations from the same individual provided we assume that these repeated trials are independent within each individual.

membership in the elements of S. The implication of this result is that independence from irrelevant alternatives need not be assumed" (Boxall and Adamowicz, 1999. p. 10).

22 Any psychometric technique that produces estimates of the latent constructs relevant to the segmentation of the population can be employed. Applied econometricians have used various methods for constructing indexes for latent psychographic variable such as the involved LISREL method (e.g. McFadden, 1986; Ben-Akiva and Boccara, 1995). Yet, as pointed out by Swait (1994), simpler approaches such as factor or principle component analysis recommend themselves over the more formal LISREL approach.

23 See McFadden (1986a), Train et al. (1986), and Morikawa *et al.* (1996) for more details on this sequential estimation approach.

3.3.4 Log-Likelihood Function

The likelihood function of Eq. 16 is maximized with respect to utility (choice) parameters β and segment membership parameters α. The log-likelihood function for N individuals that provide data for m choice sets over a set of alternatives $C,$ is given by:

$$\hat{L}(\beta,\alpha / S)=\sum_{n=1}^{N}\sum_{\forall m} f_{in}\ln\left(\sum_{s=1}^{S}\pi_{in/s}\cdot\hat{W}_{ns}\right)$$

$$=\sum_{n=1}^{N}\sum_{\forall m} f_{in}\ln\left\{\sum_{s=1}^{S}\left[\frac{e^{\mu_s(\beta_s X_{in})}}{\sum_{j\in C} e^{\mu_s(\beta_s X_{jn})}}\right]\cdot\left[\frac{e^{\lambda(\hat{a}_s Z_n)}}{\sum_{k=1}^{S} e^{\lambda(\hat{a}_k Z_n)}}\right]\right\} \qquad \text{Eq. 17}$$

The term f_{in} represents the observed frequency of individual n choosing alternative i and takes the value of '1' when this is the case and '0' otherwise. Note that in estimating Eq. 17 one must normalize the coefficients of one of the segments to be equal to zero so that the other a_s's can be identified. Hence we will estimate *S-1* segment membership parameters and S utility or choice parameters. Also, note the dependence of the segment membership function on the estimated psychographic latent variables by the inclusion of $\hat{W}_{ns}$. The latter component provides, in essence, a series of segment specific 'weights' that are applied to the choice probabilities conditional on segment membership, $\pi_{in/s}$, to obtain the unconditional choice probability of an alternative, P_{isn}. Since these weights were formulated in terms of probabilities they sum to one. That is:

$$\sum_{s=1}^{S} W_{ns}=1 \text{ and } 0\leq W_{ns}\leq 1 \qquad \text{Eq. 18}$$

Moreover, Swait and Louviere (1993) explain that within in such mixture logit models it is not possible to simultaneously identify all the scale parameters of the model. In our case these are λ and $\mu_1,\ldots,\mu_s$. The segment level scale factor λ can only be identified if we assume that $\beta_1 = \beta_2 = \ldots = \beta_s$ and $\mu_1 = \mu_2 = \ldots = \mu_s = 1$ (Swait and Louviere 1993). Yet, making this assumption would negate the very purpose of using the segment membership in the first place (i.e. to estimate different utility parameters). For this reason we assume that $\lambda = 1$.[24] Moreover following common practice in multinomial logit models we assume that the scale parameters of the choice model are all equal to one, that is $\mu_1 = \mu_2 = \ldots = \mu_s = 1$.

3.3.5 Determining the optimal number of segments

As mentioned above, in theory the total possible number of segments S may equal the total number of individuals in the sample. The aim of the estimation procedure described in Section 3.3.3 is to find the *optimal* size of S^* to characterize a particular population. The determination of S is a subjective process that requires that use of a combination of multiple statistical criteria as well as personal subjective judgment dictated by the objectives of the study. The aim is to determine whether the 'benefit' obtained from an extra segment is worth the 'cost' of the extra segment. The optimal number of segments is reached when additional segments provide little extra information or simply are superfluous. Hence, the aim is to attain 'segment parsimony', i.e. the avoidance of choosing superfluous number of segments that would lead to spurious results that do not add to our understanding of the underlying behavioural process but merely bring in undesirable noise into the model (Swait 1994).

Various criteria for determining S^* have been suggested (see McLachlan and Basford, 1988; Dillon and Mulani, 1989; Kamakura and Russell, 1989; and Gupta and Chintagupta, 1994). These criteria attempt to optimise a certain objective function that involves the log likelihood ratio statistic defined with respect to the null hypothesis that all parameters are equal to zero.[25] The shared rationale behind these criteria is to penalize log-likelihood improvements due to larger number of parameters that are estimated with each additional

[24] Assuming that scale factor for the segment membership function is equal to '1' implies that we assume that the variance of the response patterns are the same across segments.

[25] In the likelihood function presented here this is can be derived by assuming equal segment membership probabilities and equal choice probabilities (McLachlan and Basford, 1988; Swait, 1994).

segment (Louviere *et al.* 2000). Such criteria include the Akaike's Information Criterion (AIC):

$$AIC = -2(L(\hat{\beta},\hat{\alpha}/s) + (S \cdot K_{\beta} + (S-1) \cdot K_{\alpha})) \qquad \text{Eq. 19}$$

Where $L(\hat{\beta},\hat{\alpha}/s)$ is the estimated log-likelihood, K_{β} the number of parameters in β and K_{α} the total number or parameters in α.[26] The selection criterion is to choose the number of segments, s, which minimizes the AIC (e.g. Kamakura and Russell, 1989; Bozdogan, 1987).

Equivalently, one can use the Consistent Akaike's Information Criterion (CAIC) (e.g. Louviere *et al.,* 2000) and the Bayesian Information Criterion (BIC) (e.g. Allenby, 1990) which are a function of both dimensionality (i.e. number of parameters) as well as sample size (*N*):

$$CAIC = -2L(\hat{\beta},\hat{\alpha}/s) - (S \cdot K_{\beta} + (S-1)K_{\alpha} - 1) \cdot (\ln(2N)+1) \qquad \text{Eq. 20}$$

$$BIC = -L(\hat{\beta},\hat{\alpha}/s) + \left[\left(\frac{(S \cdot K_{\beta} + (S-1) \cdot K_{\alpha})}{2} \right) (\ln(N)) \right] \qquad \text{Eq. 21}$$

The value of S that minimizes each of these measures suggests the preferred model. Alternatively, applied econometricians have modified McFadden's ρ^2 to construct the Akaike Likelihood Ratio Index for deciding S*:

$$\bar{\rho}^2(s,\beta,\alpha) = 1 - \frac{AIC}{2\hat{L}(0,0/1)} \qquad \text{Eq. 22}$$

The segment membership model that maximizes this criterion is chosen (e.g. Ben-Akiva and Swait, 1986).

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26 The total number of parameters of the model is given by $(S \cdot K_{\beta} + (S-1) \cdot K_{\alpha})$

3.4. Other applications of the LS model

Similar econometric approaches based on the framework laid out in McFadden (1986a) have also been employed by the transportation literature. For example, Morikawa (1989), Ben-Akiva and Morikawa (1990), Vieira (1992), and Ben-Akiva and Boccara (1995). Yet these studies are not preoccupied with the issue of market segmentation.

Two studies from the marketing literature that have analysed revealed choice discrete choice data in the lines presented here are provided in Swait (1994) and Louviere *et al.* (2000). Also, Boxall and Adamowicz (1999) provide the only known application of the LS model in the non-market valuation literature.

Swait (1994) explore preferences for beauty aids as a function of product attributes while latent segment membership was determined by different degrees of sensitivity towards the product attributes. Swait utilized psychometric data from a sample of consumers to construct brand image ratings. He then simultaneously modelled market segmentation and product preference using a sample of repeated choices over five alternative beauty aids. Similarly, Louviere *et al.* (2000) examine choices over alternative orange juice brands.[27] They determine segments of orange brand consumers on the basis of two latent constructs (bargain proneness and propensity towards planned shopping) and assess the differences in choice attributes across segments.

Boxall and Adamowicz (1999) collected SP data over alternative wilderness parks from a sample of park visitors in Ontario Canada using a standard choice experiment survey. In addition, individual responses to recreational attitudinal and motivational questions were collected and factor analysed to construct indexes that affect membership into 'park visitor segments'. A mixed logit model similar to the one presented here was used to simultaneously determine segment membership and park choice.

[27] Gopinath and Ben-Akiva (1995) Swait and Sweeney (1996) provide a modelling approach similar to the one presented here. Yet, they assume that the latent segments are ordered with respect to an additional underlying latent dimension (e.g. the value of time, orientation towards value of money in retail shopping). In this chapter we adopt the assumption followed by Swait (1994) that no particular relationship exists between the latent segments and the latent dimensions. See Louviere *et al.* (2000) for a discussion.

The current chapter contributes to this growing literature by comparing the LS model with other models of utility and scale heterogeneity. Such comparisons are required if we are to understand how individual characteristics enter the modelling process. Further, the interpretation of the LS model somewhat differs from past applications. There appears to be the implicit view that latent class models can be interpreted as holding the middle ground between the standard complete homogeneity MN logit model and the RP model that assumes that each individual represents a segment. The LS model has thus been viewed as providing an improvement to the MN logit and a second best alternative to the RP logit model. When application of the 'first best' RP logit model is not feasible, the LS model can be applied. We believe that such *a priori* 'cardinal ranking' of these models is misleading. First of all, this view neglects the fact that even the MN logit model can account for preference heterogeneity by including individual specific interaction effects. There is no *a priori* reason the RP logit model accounts for such heterogeneity in an improved manner. Secondly, the LS model also need not be interpreted as a second best approach to the RP logit since it can provide added and unique policy information. Hence, these three sets of models may be best seen as providing different ways of accounting for preference heterogeneity and not as a series of improved models. Each model has different behavioural implications and is relevant for different policy situations. For example, the LS model may be of particular relevance when knowledge of population segments is important such as in cases where assessing the existence and nature of niche markets is vital. On the contrary, the RP model may be more relevant for accounting for preference heterogeneity over pure public goods were defining niche markets is less important from a policy point of view. This reinforces the claim made above for the need for further comparisons of alternative preference heterogeneity models.

3.5. Accounting for preference heterogeneity in RUMs: an application of the LS model

The LS model presented in Section 3.3 was explored in the choice experiment study introduced in the previous chapter. The main policy aim of this study was to assess the marginal willingness to pay for avoiding GM content in one commonly consumed food, namely eggs. The experimental design constructed a series of egg profiles characterised by different levels of five attributes: hen living condition, pesticide in chicken feed, quality information on box, GM content in chicken feed and price. The marginal WTP to avoid GM content in eggs would be given by the ratio of the coefficient of the GM content attribute over the coefficient of the price attribute (Adamowicz *et al.* 2000). Using a random parameter logit model it was found that UK individuals do in fact have a negative WTP value for increasing percentages of GM content in this particular food. These preliminary results corroborate numerous attitudinal studies that have been undertaken in Europe that have found a negative consumer predisposition towards GM content in foods. Yet, these studies have also established that the economic welfare of consumers is not affected to the same degree and in the same manner from the introduction of GM foods into the food chain. These findings are compatible with the well-established fact that the overall food industry (which includes the market for GM foods) is characterised by a particularly high level of consumer heterogeneity and dominated by the presence of influential consumer segments. (e.g. Baker and Burnham, 2001) In light of this evidence, it is understandable that we observe a general consensus emerging in both policy and industry circles that the very future of the GM food industry itself is under serious doubt unless the distributional impacts on consumer welfare from the spreading of GM foods are understood (Lusk and Hudson 2003). This requires obtaining an enhanced understanding of the sources of heterogeneity as well as the nature and relative size of market segments with respect to GM foods. [28]

The current chapter provides a direct contribution to this important policy issue by providing the first attempt to account for preference heterogeneity with respect decisions over GM foods. The aim is to obtain an enhanced understanding of how different types or segments of individuals are affected by the presence of GM contents in foods. To this end the latent segmentation model is used which is a relatively novel approach for accounting for preference heterogeneity in discrete choice data. The estimates from the LS model are compared and contrasted with those obtained from other, more commonly used, heterogeneity models. The description of the CE study that was used to explore these models was covered in great detail in Chapter 2. The only aspect of the CE study that was not described there concerned the design and analysis of the attitudinal questions included in the survey. As explained, one of the aims of the latent segmentation model developed in Section 3.3 was to follow the neglected plea made by leading micro-economists and behavioural scientists to incorporate latent attitudes and perceptions in the analysis of choice. Hence, it is only natural that the detailed discussion of the observable variables used to extract these latent precepts was left for this chapter. Sub-section 3.5.1 below describes the latent variables that were most relevant in this case study while sub-section 3.5.2 describes the questions used to construct the corresponding observable indicator variables.

3.5.1 Latent variables and preference over food products

Implementation of the LS model presented in this chapter requires the specification of the vectors of individual latent perceptual and attitudinal constructs (G^*_{np} and G^*_{na}) underpinning segment membership and choice behaviour. These vectors can conceivably include a very large number of variables. Hence, we first attempted to assess which latent concerns are the most relevant for the specific case study. This was accomplished by undertaking an extensive review of attitudinal studies on GM acceptance and by feedback obtained from focus group sessions (see Chapter 2). On the basis of the literature review and the focus groups the following latent variables were identified:

Environment and animal welfare concerns: these refer to concerns over the impact of GM foods on the state of the environment as well as on welfare of live-stock animals.

Health concerns: these refer to general concerns over health that may affect consumer food decisions.

[28] See Lusk and Hudson (2002) for arguments why the understanding of distributional impacts is more important for some issues (such as the introduction of GM foods) rather than others.

Food Safety concerns: this refers to a more specific type of latent variable that is more closely related to food safety consciousness than to overall health concerns.

Cost and bargain concerns: these would characterise an individual who has a generally high sense of 'bargains-proneness'. It is qualitatively different than price sensitivity since it may not be necessary associated with low-income groups.

Ethical concerns: these refer to moral concerns against GM technology that may affect ones food-purchasing decisions. These concerns convey the idea that GM foods may be objectionable as a matter of principle (such as the objection to 'playing God' or 'intervening in nature'). These concerns should be distinguished from a more teleological or utilitarian reasoning against GM foods (e.g. 'GM foods should be rejected since their benefits do not exceed their risks. If this were not true they would not be objectionable')

GM Risk and trust concerns: these concerns capture how risky the individual believes GM foods are and how much the individual trusts the authorities, scientists and the industry when handling/managing this new technology. Also these concerns include the level of trust in the information on the risks and benefits of GM foods that the individual receives.

Attitudes towards GM foods: captures the propensity of the individual to support GM foods on account of its various potential benefits (e.g. cost, nutrition, use less pesticides and fertilisers, taste, alleviate world hunger)

Of course this list is by no means exhaustive. The attitudinal literature on GM foods has revealed a much larger plethora of motives and concerns. Yet, in the current study we aimed at focusing on these latent concerns that are most relevant for our target population, the UK public. Hence, the final selection of the concerns that would be used in the LS model was made on the basis of the focus groups conducted in the UK. Moreover, it can be seen that the concerns listed above are both *general* concerns over food and food purchase decisions as well as *specific* concerns over GM foods in particular.[29] Finally, these concerns have been found to be related in complex ways. For example, an individual with high pro-environmental concerns may have either a positive or negative predisposition towards GM foods depending on their faith in the possible benefits from these foods. Some people may perceive GM technology as potentially beneficial for the environment (e.g. due to the use of less pesticides) and to animals (e.g. fewer disease and suffering). Yet others may perceive GM technology as posing a risk to the environment (e.g. creation of super weeds or bugs) or as inflicting abuse or violation of animal rights (e.g. genetically engineered animals).

3.5.2 Constructing observable indicators for latent variables

The next step of the estimation processes consisted of constructing observable proxy indicators of the latent concerns and attitudes mentioned above. A series of attitudinal and behavioural questions were included in the survey. The responses to these questions (obtained on a five point Likert scale) were factor analysed. The resulting attitudinal factors were then used to parameterise the vectors G_{np} and G_{na} in Eq. 9 and Eq. 10.

This process had to overcome two main obstacles. First, the type of questions to be included in the survey had to be identified. The psychometric literature provided the most obvious archive of questions that have been extensively tested in the field.[30] For example, the New Ecological Paradigm Scale developed by Dunlap *et al.* (1992) has been extensively tested for its robustness in extracting pro-environmental attitudes. A total of 130 behavioural and attitudinal questions were complied from the psychometric literature.[31] The second obstacle that had to be tackled was that of limiting the number of questions that could feasibly be included in the survey. An initial evaluation of questions was undertaken during the focus groups and initial pilot studies. Problematic and confusion questions were excluded from the initial list leaving approximately 80 questions. Further evaluation and trimming down of questions was then accomplished under the final pilot study. A split sample design was used such that each pilot sub-sample received roughly 40

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[29] This approach of considering both direct attitudes for GM foods together with more general attitudes as determinants of GM segments has been suggested by Verdurme *et al.* (2001).

[30] These test refer to issues of wording as well as the degree certain questions are suitable for capturing latent constructs.

[31] The sources from where the attitudinal variable questions were obtained were: Isaacs, 2001; Nelson, 2001; Swanson *et al.*, 2001; Nunes, 2001; Bonny, 2001, Veeman, 2001; Baker and Burnham, 2001; Henson and

attitudinal questions. Responses to these questions were factor analysed and the set of questions that returned the most clear set of factors was retained. In total 37 questions were retained which are listed in Table 3.1.[32] These were then included in the final questionnaire.

3.6. Factor analysis of responses to attitudinal and behavioural questions.

The responses to the 37 attitudinal and behavioural questions obtained from the final administration of the survey were subjected to exploratory factor analysis in order to extract proxy indicators for the latent variables affecting segment membership.[33]

Coding of the Data

The raw data used in the factor analysis consisted five point Likert scale responses ranging from 'Strongly agree' to 'strongly disagree'. For ease of interpretation, the raw data was recoded such that responses to all variables indicated the same 'direction'. Thus, going from 1 to 5 would indicate high levels of environmental, health, food safety, cost, ethical, concerns as well as *dis*trusts concerning GM information and rejection of GM foods irrespective of their potential benefits. Table 3.1 indicates which variables were recoded.[34]

Treating missing observations

The data from the attitudinal responses revealed that the majority of individuals provided responses to most but not all the attitudinal questions (82% of the sample failed to respond to between 1 and 6 out of the 37 attitudinal questions). Observations of the patterns of missing responses did not exhibit any systematic bias (e.g. increasing non-responses as we go along questions). Yet, these omissions did pose a serious practical problem. More specifically, the factor analysis would not provide factor scores for individuals that had even one missing response to the variables included in the factor analysis. Most econometric packages either drop such observations or impose some arbitrary rule to account for non-responses. This could lead to a drastic loss of sample size or to the

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Trail, 2000; Eurobarometer, 2000; Verdurme and Viaene, 2000; Heiman, 2000; Wolf, 2000; Kotchen and Reiling, 2000; Boxall and Adamowicz, 1999; Baker and Crosbie, 1993; and Dunlap *et al.*, 1992.

32 Note that the results from the final pilot and the final survey are not comparable since different CE questions and survey material was used.

33 We undertook exploratory and not confirmatory factor analysis since there was only weak and not strict *a priori* indication of which questions constitute a factor. Also, is plausible that the attitudinal and behavioural questions overlap and can reflect more than one motivational concerns.

34 Recoding the data has no bearing on the factor analysis itself. It was done merely to simplify interpretation of the results of the factor analysis.

imposition of unwarranted structure on the data. It was, thus, necessary to impute the missing responses to the attitudinal questions. [35] We followed the suggestions by Little and Rubin (1987), Bernaards and Sijtsma (2000) and (1999) for imputing categorical data used for factor analysis of multidimensional latent variables. This mainly consisted of using person and not sample mean values to impute missing responses.[36]

Performing the factor analysis

Exploratory factor analysis was performed using Stata 7.[37] Initially, the eigenvalues for all conceivable factors (i.e. thirty seven) were calculated. Then, following standard practice, factors with eigenvalues greater than one were retained (Child 1990; Harman 1976). This processes extracted five clear factors. The factor analysis was then re-run to obtain the factor loadings. Finally, the matrix with the factor loadings was rotated using the orthogonal varimax rotation method. Rotated factor loadings are presented in Table 3.2.[38] Loadings above 0.40 were considered as factoring together (Harman 1976).

Interpretation of factors

Naming the factors is a subjective processes based on the relative magnitude of the loadings. Looking at Table 3.2 we'll refer to the first factor as 'ethical resistance' since we observe high loadings in the statements that indicate resistance to GM foods on ethical grounds (statements 22-24 and 33-37). The second factor includes statements that reflect a sense of mistrust with respect to food standards and in the polices and practices adopted by relevant GM governmental, scientific and agri-industry bodies (statements 4, 11, 25 and 30-32). Also, the second factor includes statements that reflect the lack of faith in the ability of humans to overcome any potential risks involved in the use of biotechnology (statements 26, 27). Hence the factor will be labelled 'mistrust and disbelief'. The third factor reflects strong pro-environment sentiments (statements 1,2, 5 and 6) and will be

[35] Note that such a danger did not exist from the other variables included in the LS model since the non-response rates there were very low (see previous chapter).

[36] More specifically, it was decided to impute only the missing values for the respondents with few observations missing per 'group' of questions, whereby each 'group' includes the variables that are more likely to consist a factor (see in Table 1). In the cases where there were only a few missing responses within each group, then the person mean obtained from the remaining variables was used to impute the missing data. In line with the recommendations of the missing value literature we did not round off the mean figures to the closest number. In the few cases were all of the group responses were missing the data was not imputed.

[37] Confirmatory factor analysis was not used since there was no strict *a priori* indication of which questions constitute a factor. As explained in Section 5.1 it is plausible that the attitudinal and behavioural questions overlap and can reflect more than one motivational concern.

[38] For ease of interpretation the sign of all factor loadings in factor five have been reversed since this does not change the meaning of the results (Child, 1990, p. 36)

referred to as 'environment concerns'. The fourth factor reflects 'cost and bargain concerns' (statements 18-20) while the fifth 'food safety concerns' (statements 8, 15, and 16).[39]

Lastly, factor scores where obtained for every observation using the regression method suggested by Thomson (1951).[40] This process, therefore, produced data for five new variables that will be included in the vectors of individual observable indicators of latent attitudinal characteristics (i.e. G_{np} and G_{na}).

3.7. Basic Multinomial Logit model

Before running the LS model the data was explored using the standard multinomial logit (MN) logit model. This provided a first 'feel' of the data that was helpful in specifying the utility portion of the LS model (i.e. the functional form and specification of $\beta_s X_{in}$). Moreover, the MN logit model can also account for heterogeneity across individuals by including individual characteristics (interacted with choice specific attributes) directly in the indirect utility function. Hence, the results from this model can also be contrasted with those obtained from the LS model presented in the next section.

As explained in Chapter 2 the choice sets of the model included three egg profiles A, B and C and an opt-out option D.[41] The basic MN logit model assumes that the choice between these options is only a function of an alternative specific constant (ASC) and the attribute of the alternatives.[42] As explained in the previous chapter five attributes were considered taking on the following levels:

1) Hen living condition: free range Vs battery cage
2) Pesticide in chicken feed: organic Vs non-organic
3) Quality information on box: included Vs not included
4) GM content in chicken feed: 0%, 1%, 5%, 30%
5) Price of box of six medium-sized eggs: 0.38GBP, 0.68GBP, 0.98GBP, and 1.28GBP

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39 Factors with only three significant variables are acceptable provided that the loadings are large and the eigenvalue well above one. (Child, 1990, p.32)

40 For the purposes of exploratory factor analysis the literature recommends regression-scored factors over those obtained by the Bartlett method. Although regression-scored factors may be biased (while Bartlett scores are not) they are preferred since they have the smallest mean square error from the true factors (compared to Bartlett scores). (Child, 1990)

41 For simplicity we will be using the data from the no-purchase treatment. See Chapter 2 for details.

42 Since the choice experiment involves "no-brand" options the ASCs are not choice specific but equal '1' when either A, B, or C are chosen and '0' when D (i.e. the 'no purchase' option is chosen).

The binary attributes (the attributes that had two levels) entered the utility function as dummy variables but were effects coded, that is: 'Living conditions' (free range = 1, cage = -1), 'Use of agricultural chemicals and fertilizers' (non use = 1, use = -1), and 'Certification' (yes = 1, no = -1). The levels used for the price attribute were entered in a cardinal-linear form, taking four values: 0.38GBP, 0.68GBP, 0.98GBP, and 1.28GBP. Following common practice in the analysis of choice modelling data, quadratic specifications for the price attribute were also explored (see below).[43]

Similarly, the most appropriate manner to code the levels for the GM attribute was investigated. Several specifications were considered including (a) linear in GM content (i.e. 0%, 5%, 1% and 30%) which implies constant marginal utility; (b) GM content in logarithmic form (with adjustment for log(0))[44] which implies diminishing marginal utility with respect to GM content, (c) GM content levels expressed in a series of three dummy variables for 0%, 1% and 5% GM content respectively and using 30% as the base-line category. This specification implies that there is a non-linear relationship between utility and GM content; (d) a modified 'mixed' specification for GM content such that the change from 0% to 1% GM content was coded with a binary variable, "NonGM", while each subsequent level of GM content was coded as a cardinal, continuous variable, "GMCont". Hence, "NonGM" took on the value '1' when GM content was 0% and the value '0' otherwise while "GMCont" took the values 5%, 1% and 30%. The use of this mixed specification captures the idea that there is a qualitative difference between 0% and 1% levels of GM content. The inclusion of this discrete term allows for an assessment of the presence of 100% GM-free premium amongst consumers (Layton, Brown and Plummer 1999). The difference between subsequent levels of GM content (beyond 1%) are assumed to follow a cardinal, continuous measure that can be captured by a linear or log-linear specification.

The alternative coding formats for the attributes as well as the resulting indirect utility functions are summarised in Table 3.3 and Table 3.4.[45] The MN logit models were estimated for each one of these specifications. Details concerning data quality and sample size are presented in that chapter. The best fit specification was determined on the basis of

[43] For example, Swait (1994) and Cicia, Del Giudice and Scarpa (2001) have introduced quadratic price terms in the analysis of revealed and stated choice modeling data.
[44] This consisted of adding small number to zero. Various numbers (00.1, 000.1 and 0000.1) were examined.
[45] All the models in this chapter only include main effect attributes in the utility function. That is, we did not include two-way interaction effects of the attributes since we could not achieve convergence in all models.

the Swait-Louviere log-likelihood test for comparing models with different number of parameters[46] and the higher log-likelihood value criterion for cases where the non-nested competing models had the same number of parameters[47]. The results from these tests are presented in Table 3.5. The best-fit specification for $V_{ni}(X_{ni})$ was found to be:

$$V_{ni} = ASC_1 + \beta_2 \cdot LC_{ni} + \beta_3 \cdot Pest_{ni} + \beta_4 \cdot Info_{ni} + \beta_5 \cdot price + \beta_6 NonGM_{ni} + \beta_7 GMCont_{ni} \quad \text{Eq. 23}$$

That is, 'price' entered $V_{ni}(X_{ni})$ in linear form,[48] while 'GM content' entered as the mixed distribution mentioned above.

The MN model was run in GuassX using a self programmed code which is included in Appendix 2. The Appendix also includes the programme created (in LIMDEP) for converting the data set from wide to long format which is necessary to run models with multiple responses from each individual.[49] After accounting for missing data or individuals that do not consume eggs the sample size was reduced from 312 to 240 individuals.[50] These individuals provided data for 1753 choices.[51] The estimated MN logit coefficients using Eq. 23 are presented in Table 3.6. All the estimated parameters have the expected impact on utility and are highly significant. The characteristics of 'free-range', 'organic', and 'certification' have a significant and positive impact on V. Also, The impact on V of price of price negative and highly significant. Moreover, the impact on V of obtaining 100% GM free eggs is positive (given by the coefficient on the 'NonGM' dummy) while the effect on V of an increase in GM content is negative and significant. Finally, the implicit ranking of the attributes based on the marginal WTP values (or part-worths) suggests that total avoidance of GM content is the most important determinant of choice followed by the characteristics of 'free range' and 'organic' (see Table 3.14).

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46 This consist of the test statistic $-2(LL_1 - LL_2)$ where LL_1 and LL_2 refer to the log-likelihood statistics for the model with and without and the quadratic term respectively. The test statistic is asymptotically follows a χ^2 distribution with degrees of freedom equal to the difference in the numbers of parameters in estimated in the two models.

47 This is suggested by Layton, Brown and Plummer (1999) as a rough but highly accurate way of comparing nested models with the same number of parameters. It is based on Likelihood Dominance Criterion of Pollak and Wales (1991) which is an asymptotic criterion for non-nested model selection.

48 That is, the improvement in the log-likelihood value from introducing an extra quadratic term was not found to be significant.

49 Most econometric packages include a canned command for running the MN logit model. Yet, we had to construct the code for the MN logit model as part of the code for the LS model (which is not included in any econometric package). Moreover, Hanemann and Kanninen (2000) correctly point out that is best practice to always construct ones own likelihood functions (even if canned version exist) since this provides better control over the estimation process.

50 Such loss in sample size due to incomplete data is not uncommon in postal surveys (See Dillman 2000). This raises

3.8. Multinomial logit with individual characteristics

Next, preference heterogeneity was introduced into the basic MN logit model by including individual characteristics in V. Identification of the effects of these characteristics requires that they are interacted with the profile attributes. Various combinations of demographic and attributes were used. Table 3.6 presents the results from a specification that includes interactions terms between the five attitudinal variables extracted from the factor analysis and the choice specific attributes.[52] Using the Swait-Louviere log-likelihood test it can be seen that the models with interaction effects outperforms the simple model.[53] We see that the factors of "Mistrust and disbelief" and "Environment concerns" have the highest impact on the probability of choosing a particular brand. Yet, the direction of this impact remains ambiguous.

[51] That is the 240 times 8 choices per individual yields 1920 total choices made. After accounting for missing data this number is reduced to 1753.

[52] Other combinations of interaction effects provided little improvement to the overall fit and explanatory power of the model. The specification presented in Table 6 is convenient since it can be easily compared and contrasted with the results from the LS model.

[53] The test statistic is given by 2(2100.36-1813.72)=573 and the df are 30. We can easily reject that the significance of the contribution of the interaction effects is equal to zero.

3.9. Specification and estimation of Latent Segment Model

Estimation of the LS model first required the specification of the variables affecting segment membership (i.e. the vector α_s in Eq. 14). After experimentation with various specifications the five factors obtained from the factor analysis along with the socio-economic characteristics of income (in logarithmic form) and education were used (in dummy variable form such that education=1 for individuals with a university degree and education= 0 otherwise).[54] Secondly, the utility portion of the model was specified in the same manner as done in the MN logit model described above. Note that the LS model assumes that individual characteristics affect choice indirectly through their impact on segment membership. Hence, all such variables are included only in the specification of the segment membership function.

The programme for maximizing the likelihood of the LS model was coded in GaussX for Windows[55]. Both the BHHH and the BFGS algorithms for maximizing the log-likelihood of Eq. 17 were used.[56] Starting values were obtained by using the BFGS algorithm. Also, following Swait (1994) and Boxall and Adamowicz (1999) we assumed independence across multiple responses from the same individual.[57]

Table 3.7 through Table 3.10 present the results from the two, three, four, and five latent segment models. The log-likelihood, $\bar{\rho}^2$, *AIC* and *BIC* statistics of the 1, 2, 3, 4, and 5-segment solutions are presented Table 3.11. First of all we can see that the log-likelihood

[54] Note that the few known applications of the latent class models (e.g. Swait, 1994, Boxall and Adamowicz, 1999; Louviere *et al.*, 2000) have failed to converge the LS model that include socio-demographic variables in the specification of α_s. Boxall and Adamowicz (1999) admit that this failure does not allow for an adequate interpretation and understanding of the workings of segment membership processes. To cater for this shortcoming of their results the authors use a *posterior* analysis in which they regress (using OLS) socio-demographics on the estimated probabilities of segment membership. In the study presented in this chapter, however, such an analysis is unnecessary since convergence with socio-economic variables in the latent segment function was achieved.

[55] Version 3.7.1., Published by Aptech Systems Inc. under license from Econotron Software, Inc.

[56] The optimisation procedure was based on the prescriptions of Lin (2000). The workings of the BHHH and BFGS algorithms for maximum likelihood estimation are discussed in Berndt *et al.* (1974).
Details on simulation methods for estimating discrete choice mixture models are discussed in McFadden (1986b) and (1989).

[57] This assumption is quite plausible for CE studies. It is less plausible, however, in ranking studies (see Cicia, Del Giudice and Scarpa (2001). Still, future research should be directed towards developing a panel version of the LS model that can account for correlating between responses from the same individual.

and $\bar{\rho}^2$ statistics improve as more segments are added.[58] This clearly supports the presence of multiple segments in the sample.[59] As explained in Section 3.3.5 the determination of the optimal number of segments is not achieved by looking at a single criterion, but instead involves a balanced assessment of the multiple statistical criteria presented Table 3.11. The shared rationale behind these criteria is to penalize log-likelihood improvements due to larger number of parameters that are estimated with each additional segment. The ultimate aim is to achieve 'segment parsimony' and avoid choosing superfluous segments that do not add to our understanding of the underlying behavioural process but merely introduce undesirable noise into the model. Looking first at the AIC statistic, we see that it decreases as more segments are added to the model. Notice, however, that the decrease in the AIC statistic is *considerably* smaller after the third segment solution [60] indicating that the four and five segment models entail superfluous segments. Turning to the $\bar{\rho}^2$ statistics, we see that though it increases as we move across successive models, this increase is substantially levelled off after the 3-segment solution. Again this suggests that segments beyond three are superfluous. Finally, the BIC criteria is minimised at the segment model.[61] Based on a joint and balanced assessment of these three criteria it is clear that the 3-segment solution provides the best fit to the data.

58 The $\bar{\rho}^2$ more than doubles as we go from the one to the two-segment model.

59 The next section provides a more direct test of whether the LS model with optimal segments outperforms the one segment MN logit model.

60 More specifically the drop in the value for the AIC statistic is 664 between model one and two, 135 between model two and three, 35 between model 3 and four, and 33 between model four and five.

61 In order to attain the most conservative figures we follows Louviere *et al.* (2000) and used N=240 (i.e. the number of respondents) instead of the number of choice responses as the total number of observations.

3.10. Interpretation and assessment of three segment model

Having selected the model with the optimal number of latent segments we now turn to the interpretation and assessment of the three-segment model. Table 3.8 displays the results from both the segment membership and utility coefficients. The model exhibits an overall highly satisfactory fit with almost all the coefficients being highly significant.

The labelling of each segment is, like the labelling of factors, a subjective processes based on the overall fit of the model and relative significance and magnitude of the coefficients in the latent segment membership function.[62] The segment membership coefficients for the first segment were normalised to zero in order to be able identify the remaining coefficients of the model. All other coefficients are to be interpreted relative to the normalised or base-line first segment.

Observing the membership coefficients in 'Segment 2' we can see that the likelihood of belonging to this segment is highly influenced by pro-environmental concerns, concerns over food and health safety, strong ethical concerns against the use of biotechnology in food production and mistrust and disbelief over the information received about GM foods. This segment is also characterized by high income and medium to low education levels. The segment may be, thus, labelled the 'food cautious' segment on account of the relative strength of factors on food safety and mistrust. 'Segment 3' is characterised by low environmental and food-safety concerns but by very strong ethical principles against the use of biotechnology as well as high mistrust over GM information received by the government, scientists, and the industry. Also, individuals in this segment are characterised by relatively low-income which is consistent with 'bargain proneness'. The segment is labelled 'ethical opponents' on account of the relatively strong ethical opposition to GM foods. The segment membership coefficients of 'Segment 1' can only be implicitly interpreted since they cannot be directly estimated. This is accomplished by observing the signs from the estimated parameters obtained from the other two segments. However, this can only be unambiguously achieved in cases where the estimated membership coefficients have the same sign across segments. It can be seen that individuals in this segment are

[62] The subjective process of labelling segments and identifying the likelihood that each individual belongs to a particular segment has affinities to the work by Langford *et al.* (2003 and 1998) that used cultural theory to assess public perceptions of health risks from polluted coastal bathing waters. Their work found that individuals could not conform perfectly to any one type of cultural type. Exploring avenues for cross-fertilization between cultural theory and latent variable analysis is an interesting field for future research.

characterised by low ethical barriers against GM goods and trust in the information obtained from GM authorities and stakeholders. This segment will, thus, be labelled 'food optimists'. Lastly note that no segment is characterised purely by one type of concern. The model allows for attitudes to overlap since it acknowledges that individuals (or segments of individuals) are complex and multifaceted entities.

Turning to the utility parameters we see that the coefficients on NonGM and egg brand information are insignificant for the 'food optimist' segment which is consistent with the group's ethical acceptance of GM foods and overall trust and optimism with respect to managing the risks involved in GM food production and consumption. Notice, however, that the parameter on GMCont is negative and significant, indicating that individuals in this segment will receive a disutility from an increased percentage of GM content in food but are not affected by the presence of small traces of GM content (below 1%) since the 'NonGM' dummy is insignificant. Yet, note that the 'GCont' parameter is considerably smaller than that in the other segments reaffirming the idea that this segment is more open towards GM foods.

The utility component of the 'food cautious' segment is strongly influenced by concerns over the treatment of animals and use of pesticides in food production processes. This is consistent with the strong pro-environmental, food-safety and health concerns determining membership in this segment. Moreover, these individuals receive negative utility from a percentage increase in GM content beyond the 1% level (i.e. the GMCont parameter is negative and significant) as well as a 'premium' utility from the total (i.e. 100%) elimination of GM content in foods (i.e. NonGM parameter is positive and significant). Notice, however that the GMCont parameter is larger than the NonGM parameter indicating that the total elimination of GM content in foods has a (relatively) smaller impact on utility. This is consisted with the overall make-up of this segment which is less dogmatic about the elimination of GM foods as suggested by its low coefficient on the ethical resistance factor.

In contrast, in the 'ethical resistance' segment the 'NonGM' parameter has a relatively larger impact on utility than the 'GMCont' parameter. This is consistent with individuals in this segment being opposed to GM foods on ethical grounds. [63] Also, note that the parameters on 'living condition' and 'pesticides' are relatively much less important (in terms of significance and magnitude) which is in line with the low environmental and food-safety concerns that characterise this segment. [64]

The relative size of each segment (or market share) can be estimated by inserting the estimated segment coefficients into Eq. 14. This will provide the series of probabilities that each individual *n* belongs to each of the three segments. Individuals are assigned to one of the three segments on the basis of their largest probability score. We thus find that 53.5% of the sample is classified into the 'food optimist' segment that includes individuals that are cautiously in favour of GM foods. Moreover, 38.8% can be classified into the 'food safety cautious' segment that includes people that are against GM foods on environmental and health risk grounds. Lastly, the marker share of the 'ethical opponents' segment is 7.7%. This includes individuals that oppose GM foods on ethical grounds and have a relatively stronger propensity to object to even traces of GM content in food (i.e. traces of GM content below 1%). We can thus conclude that roughly half of the sample is open to the possibility of consuming GM foods while the other half has rather a strong negative predisposition towards GM foods.

These results are in line with other GM food segment studies that have used non-behaviour based cluster analysis techniques. For example Verdrume *et al.* (2001) 'cautious and food Neophobics', 'enthusiasts' and 'green opponents' segments directly correspond to the 'food safety cautious' 'ethical opponents', and 'food optimist' derived here. The results are also in line with the segments obtained by studies by Baker and Burnham (2001) and Baker and Crosbie (1993). All of these studies use some form of cluster analysis to distinguish consumer segments in relation to GM foods. The segments revealed via the LS model, however, are based on a behavioural model of choice. This makes the information more operationally valuable than those obtained from simple cluster analysis (Ben-Akiva *et al.* 1997).[65, 66]

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63 The consisted relationship between the segment membership and utility parameters follows from the joint estimation of these two vectors.

64 See Section 3.5.1 for a discussion of the complex relationship between factors.

65 Still, the affinities of our results with those obtained from cluster analysis studies provide a form of external validity and/or convergent validity. Also, Hossain *et al.* (2002b) have conducted a qualitative study in which they assess consumer acceptance of various types of GM foods in the US. One of the foods they investigate is in fact eggs laid by hens that have been feed with GM chicken feed. They find that roughly 50% of the sample would be willing to purchase these eggs while 50% would not. This is an interesting finding since it suggests that consumer preference across the Atlantic may not be as different as argued by many. GM opponents in Europe are usually much more vocal and dominate the public debate to the extent that they have influenced policy decisions.

66 Recent valuation work on the welfare impacts of introducing GM foods have investigated preference heterogeneity by focusing on demographic characteristics such as age and sex (e.g. James and Burton 2001).

Moreover, we can compare the LS model with the MN logit model that includes interacted individual characteristics. Using the Swait and Louviere log-likelihood test we find that the former outperforms the latter. The chi square statistic is 78.46 which can reject the null that the MN is the correct specification at the 1% level. Hence, based on statistical criteria the LS model outperforms the MN model with interacted individual characteristics in accounting for preference heterogeneity .

We can further appreciate the policy usefulness of the LS model by comparing the part-worth values (or the marginal rate of substitution between income and a change in the attribute in question) of the 3-segment model with those obtained from the single segment MN logit model (with and without individual characteristics). Table 3.14 presents part-worth values of each attribute from both models as well as the ranking (i.e. relative importance) of these attributes.[67]

Initial inspection of this table shows that the *relative* importance (i.e. ranking) of each attribute differs from one segment to the other.[68] For instance we see that in the MN logit model (in both the basic and complex versions) the NonGM attribute has the largest part-worth value. In other words, the MN logit model ranks the NonGM attribute above all other attributes. Looking, however, at the (statistically superior) 3-segmen model, we obtain a substantially different view of the relative importance of this particular attribute. More specifically, we see that the 'food optimists' and 'food cautious' segments (which constitute 93 % of the sampled population) rank this attribute in the third and fifth place respectively. This implies that the single segment MN logit model *overstates* the importance of eliminating the last 1% GM content level in chicken feed.[69]

Yet, the large number of qualitative studies on GM foods have found that attitudinal and motivational (as opposed to purely demographic) variables are more appropriate in explaining differences in choice. The current study provides one of the first attempts to incorporate such latent constructs in a quantitative model of choice.

[67] These were calculated in accordance with McFadden (1999). Note that calculation of segment specific marginal welfare measures presupposes that we have assigned respondents to segments. That is, the formula for part-worth values follows directly from that of 'total' WTP:

$$CV_{n/s} = \frac{-1}{price_s}\left[\ln\left(\sum_{i\in C} e^{\beta_s X_i^0}\right) - \ln\left(\sum_{i\in C} e^{\beta_s X_i^1}\right)\right]$$

[68] Note that the absolute (as opposed to relative) magnitude of the part-worth values seems quite large and are not as such to be used for policy purposes. What is useful from this table is to see how (qualitatively) the relative importance of part-worth values changes across segments.

[69] The results from the LS model also allow for the estimation of a *single* (as opposed to segment specific) welfare measure. This is calculated by estimating the weighted sum of the segment specific welfare measure.

The policy usefulness of the LS model can be further explored by comparing the ranking of attributes *across the three* segments.[70] For example, we can see that the individuals in the 'ethical opponent' segment are willing to pay a relatively higher premium to eliminate *all* traces of GM content in foods compared to the other two segments. That is, the value of the NonGM attribute is ranked first and has a relatively higher value than that exhibited in the other segments. Turning to the 'food cautious' segment we see that it is characterised by individuals that have a relatively higher marginal WTP to avoid *excessive* percetagnes GM content in food compared to their marginal WTP for eliminating *all* traces of GM content in foods (the NonGM attribute is ranked fifth while the GMCont is ranked second). This result is compatible with the results obtained from the focus group sessions of this study as well as from numerous other qualitative marketing studies according to which several individuals have an understanding of the 'opportunity costs' involved in eliminating all GM food production as well as all forms of contamination of non-GM foods.[71] That is, it has been found that several individuals espouse the view that halting the production of all GM crops or even sustaining complete segregation of GM and non-GM foods is economically unattainable. As a result, these types of individuals would be willing to pay relatively higher amounts to avoid consuming foods with a large GM content, but would have a relatively lower WTP to avoid minute traces of GM content in their food. These preferences are compatible with those related to the decisions over purchasing food products that contain threshold levels of certain apparently 'undesirable' substances. Examples include decisions over purchasing food products containing various levels of pesticides, additives and preservatives. Lastly, it is interesting to note that the

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where the weights are the estimated market share or segment membership probabilities. Again the formula for marginal WTP (or part-worth) stems directly from to 'total' WTP function:

$$CV_n = \sum_{s=1}^{3}\left\{W_{ns}\cdot\left[\frac{-1}{price_s}\left[\ln\left(\sum_{i\in C}e^{\beta_s X_i^0}\right)-\ln\left(\sum_{i\in C}e^{\beta_s X_i^1}\right)\right]\right]\right\}$$

This measure may be viewed as 'correcting' the standard (homogeneous) welfare measure estimates in that it accounts for preference heterogeneity. From Table 14 we see that the failure to account for preference heterogeneity at the segment level may over or under estimate marginal WTP values. Hence, granted that the LS model is the correct specification (based on the Swait and Louviere log-likelihood test) any policy decisions made on the basis of the MN logit model would be erroneous. The differences in 'total' welfare estimates are not discussed further since the main point we wish to make in this chapter is that the LS model provides enhanced information on the *distributional* impacts alternative GM levels across segments. Hence, the remaining discussion of WTP estimates concerns segment specific values.

70 Though the study focused on choices over alternative egg brands, the qualitative distributional implications can be discussed in terms of decisions over 'food' in general.

71 Individuals participating in such studies appreciate that eliminating all traces of GM foods may increase food prices as well may be socially undesirable.

‘food optimists’ provided the lowest rank for the ‘GMCont’ attribute compared to the two other segments.[72] Also, the ‘food optimists’ exhibit the smallest WTP to avoid increments of GM content in foods across all three segments. These results are compatible with a segment that is more open to the use of biotechnology in the production of food as discussed in Section 3.10.

It is clear that any policy decisions made on the basis of the single segment model would not reflect the richness and heterogeneity in utility attributes that exists in the sampled population. Hence, the overall results from the LS model may provide more useful input into the various aspects of the GM food debate such as those over labelling and market segregation.

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72 The part-worth value associated with the NonGM attribute for the ‘food optimists’ segment is statistically equal to zero (see Table 3.8).

3.11. The Random Parameters logit model

We now turn to compare the results from the LS model with those derived from the random parameter logit model. The rationale behind this model was described in Section 3.2.2. The basic formulation of the model is a generalisation of the MN logit model given by that allows for both systematic and random heterogeneity (see Louviere *et al.*, 2000 and Green, 1997). The model includes fixed parameters akin to those estimated under the standard MN logit model but also random parameters that are assumed to follow some predefined probability distribution. Estimates of the fixed parameters as well as estimates of the mean and standard deviation of the random parameters are obtained via simulated maximum likelihood. The estimation process was undertaken in LIMDEP (Version 7.0.2) following the guidelines of Green (1998, pp. 540-542) and Louviere *et al.* (2000, pp. 200-201). The random parameters were assumed to be normally distributed while simulated probabilities were based on 500 replications. [73] The code that was constructed for running the RP logit is included in Appendix 2. Various combinations of choice attributes and individual characteristics specified either as random or fixed parameters were explored. Table 3.12 presents the best-fit specification that assumes the choice attributes are random and individual characteristics fixed.[74]

Looking at the results we first see that the coefficients of the derived standard errors of the random parameters are insignificant in all three RP logit models. Secondly, the coefficients on individual characteristics are mostly significant. Thirdly, the coefficients on the choice invariant attributes are also significant and exhibit the desired sign. These results provided initial indication that although the data supports the presence of systematic or conditional preference heterogeneity (something that has already been determined from the MN model), there does not seem to be justification for the presence of random or unconditional preference heterogeneity. Yet the RP model should not necessarily be ruled out, however, in favour of the MN model even when random heterogeneity is not present. This is because the RP logit exhibits additional attractive features, the most notable one being the non-reliance on the IIA assumption. In fact using a likelihood-ratio test we reject

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[73] For some of the random parameters the log-normal distribution (instead of the normal) may appear as a more plausible assumption. For example, the attribute of 'living condition' would most likely be a 'good' as opposed to a 'bad' for most people. Yet, the RP logit model failed to converge under alternative distributional assumptions.

[74] The specifications where all variables were set to be random failed to converge.

the restrictive MN model (in which all coefficients are restricted to be deterministic) in favour of the RP logit model. It is left to be seen, therefore, whether the RP logit model is more suitable in accounting for systematic preference heterogeneity compared to the LS model.

Formal comparison of the two specifications is complicated by the fact they are non-nested models. We use the test presented in Ben-Akiva and Swait (1986) for comparing for non-nested probabilistic choice models. [75] The idea behind this test is to examine whether the systematic preference heterogeneity in this particular data set can be better explained at the individual or at the segment level. The Ben-Akiva and Swait test rejects the null hypothesis that the RP logit model is the true specification. Hence, the RP logit model (and the estimation complexity it requires) appears to be superfluous. This result may reflect the fact that (for this particular study) the LS model provided added information that was not conveyed in the RP logit model. For example, though the coefficients on individual characteristics in the RP model were highly significant, they are considerably less interpretable and operationally useful than those obtained for each segment under the LS model. Also, the statistical supremacy of the LS model is implying that individual characteristics are affecting choice *indirectly* (through the segment membership function) rather than directly through the utility function. Lastly, we can see from Table 3.14 that the implicit ranking of the marginal WTP values (i.e. part-worth values) derived from the RP logit model differs from that derived from the LS model. This reinforces the need to use

[75] The test was developed by Horowitz (1983). Here we focus on the exposition by Ben-Akiva and Swait (1986) test for comparing two non-nested models *j=1,2* we first calculate the following measure of fitness for each model:

$$\bar{\rho}_j^2 = 1 - \frac{L_j - K_j}{L(0)}$$

where L_j is the log-likelihood at convergence for model *j*, $L(0)$ is the log-likelihood for the data assuming choice us random (i.e. all alternative are equiprobable) and K_j are the number of parameters of each model. If model 2 is more parsimonious (i.e. $K_1 > K_2$), then the null hypothesis will be that the more parsimonious model is the 'true' specification. In our case this would be the RP logit model. The null hypothesis cannot be rejected if the following condition holds

$$prob\left(\left|\bar{\rho}_2^2 - \bar{\rho}_1^2\right| \leq Z\right) \leq \Phi\left(-\sqrt{-2ZL(0) + (K_1 - K_2)}\right)$$

Where Φ is the standard normal CDF. This condition does not hold (for $\bar{\rho}_2^2 - \bar{\rho}_1^2 = 0.017$ and L(0)=-2.1786) and hence we reject the null the the RP logit is the correct specification.

the best-fit LS model for policy purposes since the two types of models led to different conclusions regarding the distributional impacts of GM foods.[76]

3.12. Exploring variance heterogeneity: the CovHet model

The analysis so far has assumed that differences in individual characteristics may affect utility parameters. Using data from a CE on preferences for alternative egg profiles it was shown that the LS model outperformed other models that account for preference heterogeneity. Yet, Louviere *et al.* (2000) and Swait and Bernardino (2000) have pointed out that it is worth investigating whether data on individual characteristic are associated with differences in choice variability (consistency) instead of differences in choice attribute sensitivity. This is equivalent to investigating whether systematic heterogeneity should be sought after in the stochastic component of the utility function, ε_{ni}, instead of in the non-stochastic component $V_{ni}(\beta X)$. Models that explore variance heterogeneity are referred to as variance heteroscedasticity models since they relax the assumption that all individuals have the same error variances (i.e. they relax the *iid* assumption). This implies that individuals are allowed to have different levels of noise in their decision-making (Breffle and Morey, 2000; Johnson and Desvouges, 1997).[77] In practical terms this translates into allowing for the scale parameter, μ, to vary across individuals. The covariance heterogeneity (CovHet) model introduced in Section 3.2.5 allows for such a possibility by parameterising μ with individual characteristics.[78] By running such a model and then comparing it to the LS model we can investigate whether individual characteristics are more suitable for explaining heterogeneity in 'variance' instead of taste. From the formula of the variance of the error term it is clear that the scale parameter is inversely proportional to $\sigma_{\varepsilon_{ni}}$.[79] Hence, an individual with a small (large) amount of noise

[76] We did not indulge in further comparative analysis of welfare measures across the RP, LS and MN logit models. Numerous studies have shown that these welfare measures tend to significantly differ across models while the direction of the divergence has been found to vary (see for example studies by Morey and Rossmann, 2002; Breffle and Morey, 2000; Alpizar and Carlsson, 2001; Layton and Brown, 1999; Train, 1998). Ultimately, the magnitude and direction of differences in welfare measures is data specific. In practice we should use the welfare measure derived from the model that outperforms all other specifications on statistical and behavioural grounds.

[77] Although the assumption that the $\varepsilon's$ are independent across choice occasions need not be relaxed.

[78] Other variance heteroscedasticity model allow μ to be random. These models are not explored here since they do not explore the source of the variance heterogeneity (see Breffle and Morey, 2000). See Louviere *et al.* (2000, pp.189-282) for a review of alternative scale heterogeneity or variance heteroscedasticity models.

[79] In the MN logit model the $\varepsilon_{ni}'s$ are independently drawn from a univariate extreme value distribution with cumulative distribution function $F(\varepsilon) = e^{-e^{-\mu(\varepsilon)}}$ where $\mu > 0$. The mean and variance of the distribution

in the decision process will have a relatively large (small) μ, and the model will predict the individual's choices relatively well (poorly) (Breffle and Morey, 2000). Consequently the scale parameter may be interpreted as a measure of the error or lack of precision or consistency in the subject's choices.

The CovHet model was estimated in LIMDEP (Version &.0.2). The estimation code that was created for this purpose is included in Appendix 2. In order to facilitate comparison with the LS model the scale function was parameterised with the same variables used to account for preference heterogeneity. The results from the CovHet model are included in Table 3.13. The estimated choice parameters have the expected sign and are significant. Also, the covariates of the scale function are all significant. This implies that the scale (variance) of the random component of utility increases (decreases) with increases (decreases) in these covariates.

The log-likelihood of the CovHet model will be by definition higher (in absolute terms) than that of the three segment LS model since the latter has more parameters. The empirical issue is whether the additional explanatory power from the model with more parameters is significant enough to reject the more parsimonious CovHet specification. Once again the two models are non-nested so we employ the Ben-Akiva and Swait (1986) test described in the previous section. On the basis of this test we reject the null hypothesis that the CovHet model is the correct specification.[80] It is therefore, more likely that (for this particular study) the LS model that uses individual characteristics to explain parameter differences (or preference heterogeneity) across types of segments of individuals provides a better fit to the data than the CovHet model that uses individual traits to explain consistency (or variability) of individual choices.[81] Finally, we can see from Table 3.14

are given by $E(\varepsilon)=(0.57721/\mu)$ and $\operatorname{var}(\varepsilon)=\sigma_\varepsilon^2=\dfrac{\pi^2}{6\mu}$. See Morey (1999) for a discussion of the extreme value discussion and its application to discrete choice models.

[80] That is, the condition:

$$prob\left(\left|\bar{\rho}_2^2-\bar{\rho}_1^2\right|\le Z\right)\le\Phi\left(-\sqrt{-2ZL(0)+(K_1-K_2)}\right)$$

does not hold (for $\bar{\rho}_2^2-\bar{\rho}_1^2=0.0023$ and L(0)=-2.6967) and hence we reject the null that the CovHet model is the correct specification.

[81] One possible criticism of this result is that we have not used appropriate variables to parameterise the scale parameter. For example latent variables on cognitive ability or how people perceive choice attributes may have been more appropriate. The factor analysis variables we have used instead were designed for capturing taste and not variance heterogeneity. Still the fact that the LS model outperforms the CovHet model provides justification that our results are consistent with the theory motivating the LS model.

that the implicit ranking of the marginal WTP measures for the two types of models differs and hence it is not inconsequential for policy purposes which model is used.

3.13. Concluding remarks and recommendations for future research

There are both statistical and behavioural arguments for accounting for preference heterogeneity in random utility discrete choice models. The former concern the accuracy of the estimated parameters while the latter have to do with the policy relevance of the results. The current chapter presented an alternative approach to account for preference heterogeneity in random utility models, the latent segmentation (LS) model. The model was formulated along the behavioural framework developed by McFadden (1986a) in which latent attitudinal and motivational constructs indirectly affect choice through their impact on segment membership. This structural model was used to construct a statistical model that simultaneously estimates segment membership and choice.

The model was applied to a data set derived form a choice experiment investigating the impact that the introduction of GM foods would have on individual food purchasing decisions. The analysis compared the LS model with other specifications and found that it outperformed all rival models on statistical grounds. Further, the implicit ranking of the estimated implicit prices varied considerably across models signifying that care must be taken when choosing appropriate specification for treating heterogeneity. Also the LS model was shown to provide richer policy information, and hence, in this instance, was found to be superior on policy grounds.

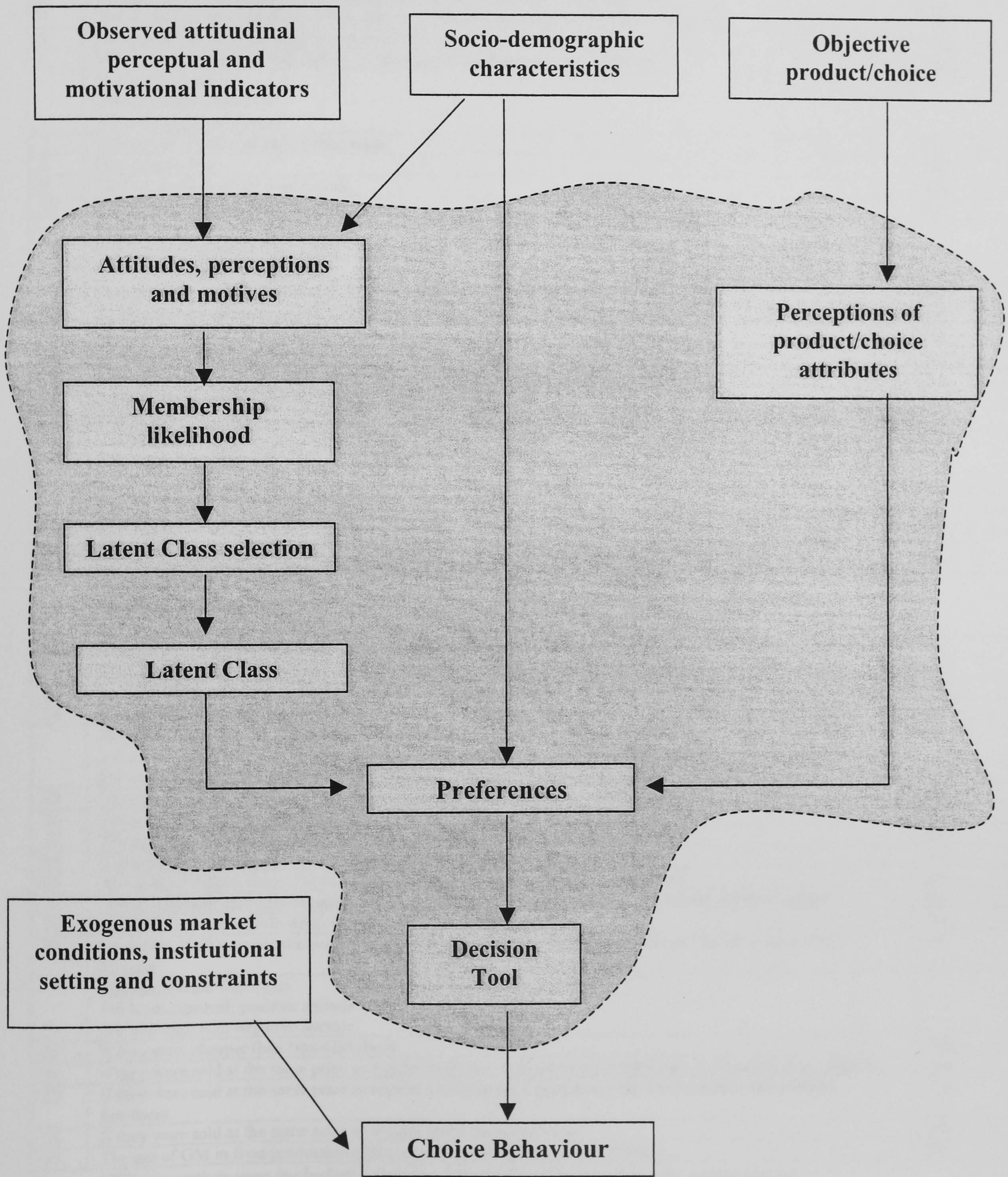
The use of latent class models that integrate information from choice models with latent constructs and socio-economic factors is an exciting field for further research. Most notably, some research has begun on exploring alternative membership functions. For example, Swait and Sweeny (1996) utilize an ordered probability model to develop an ordered latent segment model in which segments differ according to the relative importance placed on characteristics of a particular purchase situation. Boxall and Adamowicz (1999) postulate that such a method may be helpful in environmental damage assessment where it would be useful to know if values differed according to the importance of the use of the damaged area by different groups of citizens.

Moreover, Ben-Akiva *et al.* (1997) point out that in order for the latent constructs used in the membership function to have adequate explanatory power they must be relevant to the choice context being examined. This highlights the need for interdisciplinary research between environmental economist and social psychologists in order better understand latent environmental attitudes and perceptions as well as to develop better proxy indicator variables.

This last area of research is also very important if we wish to use choice models that incorporate psychographic information to make out-of-sample prediction. Boxall and Adamowicz (1999) argue that what we should be aiming it at with respect to out-of-sample prediction is increasing our confidence in allocating out-of-sample individuals to segments and then using the segment-specific choice parameters to predict their behaviour. In most environmental problems such prediction is very difficult since we mostly have 'non-users' that leave a very scant behavioural and attitudinal trails. Hence, successful out-of-sample prediction will require the development of attitudinal questions and sufficient understanding of the answers to these before out-of-sample individuals can be allocated to segments with confidence (Boxall and Adamowicz, 1999).

3.14. Appendix 1: Figures and Tables

Figure 3.1 A Structural model of latent segmentation and choice (adapted from McFadden (1986), Ben Akiva *et al.* (1997) and Swait (1994)).



Notes: shaded segment includes latent or unobservable constructs.

Table 3.1 Grouping and coding of attitudinal and Behavioural questions.

	Environment and animal welfare concerns 1→ low environmental concerns 5→ high environmental concerns	Reversed coding
1	The earth is like a spaceship with very limited room and resources	Yes
2	The balance of nature is very delicate and easily upset	Yes
3	The so-called 'ecological crisis' facing human kind has been greatly exaggerated	No
4	The welfare of animals produced for human consumption is as good as can be expected	No
5	Humans are severely abusing the environment	Yes
6	When humans interfere with nature, it often produces disastrous consequences	Yes
	Health Conscious 1→ not health conscious 5→ very health conscious	
7	Use a water purifier or buy bottled water	No
8	Buy organic food	No
9	Eat fast foods or ready-made meals	Yes
10	Take dietary supplements	No
	Food Safety 1→ not worried about food safety 5→ worried about food safety	
11	I am satisfied that the additives in food today are not harmful to my health	No
12	Restaurants do not take enough care when handling foods	Yes
13	Of all the risks we have to face at the moment, that of food safety is rather insignificant	No
14	Government should spend more money on increasing food safety	Yes
15	Look at the labels on food packaging for information on nutrition and ingredients	No
16	Look at the labels on food packaging for information on food safety	No
	Cost Conscious 1→ not cost conscious 5→ very costs conscious	
17	Make a detailed shopping list before going grocery shopping	No
18	Use coupons or special offers when buying food	No
19	Stock up on food items when they are on sale	No
20	Go to many stores to search for the best bargain when going grocery shopping	No
	Ethics Conscious 1→not ethics conscious 5→ very ethics conscious	
21	Humans have the right to modify the natural environment to suit their needs	No
22	If a majority of people were in favour of GM food, it should be permitted	No
23	Even if GM food has advantages, it is basically against nature	Yes
24	GM technology should not be used even for medicinal purposes	Yes
	Risk and Trust 1→ does not worry about GM foods and believes that risks can be controlled; trust information from authorities 5→ worries about GM food and does not trust information and the authorities	
25	Information about food safety and nutrition on food labels can be trusted*	No
26	The public can avoid eating GM foods if they want to	No
27	Whatever the risks involved in GM food, we can avoid them if we really want to	No
28	If something went wrong with GM food, it would be a global disaster	Yes
29	Any adverse effects from GM foods are only likely to emerge in the distant future	No
30	The government carefully monitors the correct use of GM in the medical, agricultural and food sectors	No
31	Scientists are responsible when working with GM technology	No
32	Producers of GM crops take potentially harmful consequences to human health and the environment into account	No
	Attitude toward Gm foods 1→ high approval; positive attitude 5→ low approval; negative attitude	
33	If they were cheaper than Non-GM foods	Yes
34	If they were sold at the same price as regular foods but were much more nutritious or contained more vitamins	Yes
35	If they were sold at the same price as regular foods but were produced with less pesticides and artificial fertilisers	Yes
36	If they were sold at the same price as regular foods but tasted better	Yes
37	The use of GM in food production offers a solution for the world food problem	No

*Notes: *This question was included twice (as 25v and can be used to test consistency)*

Table 3.2 Factor analysis of attitudinal and behavioural questions.

		Factor Loadings				
		FA 1	FA 2	FA 3	FA 4	FA 5
1	*The earth is like a spaceship with very limited room and resources*	0.234	0.043	**0.439**	0.010	-0.024
2	*The balance of nature is very delicate and easily upset*	0.264	0.104	**0.536**	0.099	0.103
3	*The so-called 'ecological crisis' facing human kind has been greatly exaggerated*	0.036	0.382	0.135	-0.156	0.083
4	*The welfare of animals produced for human consumption is as good as can be expected*	0.103	**0.475**	0.134	0.003	0.256
5	*Humans are severely abusing the environment*	0.217	0.129	**0.676**	-0.031	0.107
6	*When humans interfere with nature, it often produces disastrous consequences*	0.286	0.047	**0.614**	-0.026	0.122
7	*Use a water purifier or buy bottled water*	0.077	0.164	0.024	0.140	0.339
8	*Buy organic food*	0.220	0.268	0.074	-0.080	**0.446**
9	*Eat fast foods or ready-made meals*	0.240	0.037	0.188	-0.090	0.169
10	*Take dietary supplements*	0.103	0.184	-0.002	0.102	0.254
11	*I am satisfied that the additives in food today are not harmful to my health*	0.221	**0.523**	0.209	-0.077	0.224
12	*Restaurants do not take enough care when handling foods*	0.054	0.036	0.273	0.072	0.014
13	*Of all the risks we have to face at the moment, that of food safety is rather insignificant*	0.241	0.358	0.057	0.033	0.24
14	*Government should spend more money on increasing food safety*	0.195	0.020	0.306	-0.046	0.089
15	*Look at the labels on food packaging for information on nutrition and ingredients*	0.181	0.119	0.059	0.001	**0.629**
16	*Look at the labels on food packaging for information on food safety*	0.183	0.087	0.165	0.012	**0.688**
17	*Make a detailed shopping list before going grocery shopping*	0.102	-0.018	0.034	0.239	0.209
18	*Use coupons or special offers when buying food*	-0.064	0.030	0.044	**0.599**	0.074
19	*Stock up on food items when they are on sale*	-0.139	0.034	-0.026	**0.619**	-0.091
20	*Go to many stores to search for the best bargain when going grocery shopping*	0.027	-0.055	-0.073	**0.472**	0.057
21	*Humans have the right to modify the natural environment to suit their needs*	0.379	**0.401**	0.175	0.108	0.039
22	*Even of a majority of people were in favour of GM foods, they should still not be permitted*	**0.490**	0.317	0.224	-0.010	0.192
23	*Even if GM food has advantages, it is basically against nature*	**0.459**	0.102	0.313	-0.049	0.103
24	*GM technology should not be used even for medicinal purposes*	**0.420**	0.082	0.220	-0.013	0.009
25	*Information about food safety and nutrition on food labels can be trusted*	0.153	**0.430**	0.056	0.207	0.051
26	*The public can avoid eating GM foods if they want to*	0.110	**0.735**	-0.005	-0.034	0.098
27	*Whatever the risks involved in GM food, we can avoid them if we really want to*	0.189	**0.723**	0.005	-0.039	0.073
28	*If something went wrong with GM food, it would be a global disaster*	0.261	-0.002	0.319	-0.048	0.165
29	*Any adverse effects from GM foods are only likely to emerge in the distant future*	-0.124	0.185	-0.162	-0.174	0.019
30	*The government carefully monitors the correct use of GM in the medical, agricultural and*	0.234	**0.647**	0.154	0.080	0.057
31	*Scientists are responsible when working with GM technology*	0.170	**0.641**	-0.053	0.096	-0.011
32	*Producers of GM crops take potentially harmful consequences to human health and the environment into account*	0.254	**0.543**	0.144	-0.037	-0.061
33	*If they were cheaper than Non-GM foods*	**0.858**	-0.100	-0.104	0.053	-0.026
34	*If they were sold at the same price as regular foods but were much more nutritious or contained more vitamins*	**0.917**	-0.084	-0.067	0.007	-0.04
35	*If they were sold at the same price as regular foods but were produced with less pesticides and artificial fertilisers*	**0.889**	-0.119	-0.071	-0.005	-0.053
36	*If they were sold at the same price as regular foods but tasted better*	**0.919**	-0.120	-0.094	0.007	-0.134
37	*The use of GM in food production offers a solution for the world food problem*	**0.549**	-0.301	-0.089	0.061	-0.024
		7.877	**2.418**	**1.457**	**1.211**	**1.059**

Where:

Factor 1: Ethical resistance
Factor 2: Mistrust and disbelief
Factor 3: Environment concerns
Factor 4: Cost and bargain concerns
Factor 5: Food safety concerns

Table 3.3. Description of alternative coding formats for choice attributes

Variable	Description
Living condition	Living conditions; 1 for free range, -1 battery cage
Pesticides	Pesticides use in chicken feed; 1 no use, -1 use
Information	Information/certification; 1 included; -1 not included
Price	Price of box of six medium sized eggs; 0.38GBP, 0.68GBP, 0.98GBP, 1.28GBP
GMCont	Cardinal measure of GM content taking the values 0%, 5%, 1% and 30%
LogGM	logarithm of GM continuous (adjustment required for log(0)
GM0, GM1, GM5	Dummy variables for levels of GM content (base-line 30%)
NonGM	Qualitative variable for difference between 0 and 1% GM content; 1 for 0% and 0 for 1% or above

Table 3.4. Alternative specifications considered in preliminary/exploratory investigation of indirect utility function

1)	$V_{ni} = ASC_1 + \beta_2 \cdot LC_{ni} + \beta_3 \cdot Pest_{ni} + \beta_4 \cdot Info_{ni} + \beta_5 \cdot price + \beta_6 GM_{ni}$
2)	$V_{ni} = ASC_1 + \beta_2 \cdot LC_{ni} + \beta_3 \cdot Pest_{ni} + \beta_4 \cdot Info_{ni} + \beta_5 \cdot price + \beta_6 \log(GM_{ni})$
3)	$V_{ni} = ASC_1 + \beta_2 \cdot LC_{ni} + \beta_3 \cdot Pest_{ni} + \beta_4 \cdot Info_{ni} + \beta_5 \cdot price + \beta_6 GM0_{ni} + \beta_7 GM1_{ni} + \beta_8 GM5_{ni}$
4)	$V_{ni} = ASC_1 + \beta_2 \cdot LC_{ni} + \beta_3 \cdot Pest_{ni} + \beta_4 \cdot Info_{ni} + \beta_5 \cdot price + \beta_6 NonGM_{ni} + \beta_7 GMCont_{ni}$
5)	$V_{ni} = ASC_1 + \beta_2 \cdot LC_{ni} + \beta_3 \cdot Pest_{ni} + \beta_4 \cdot Info_{ni} + \beta_5 \cdot price + \beta_6 NonGM_{ni} + \beta_7 \log(GMCont_{ni})$
6)	$V_{ni} = ASC_1 + \beta_2 \cdot LC_{ni} + \beta_3 \cdot Pest_{ni} + \beta_4 \cdot Info_{ni} + \beta_5 \cdot price + \beta_6 \cdot price^2 + \beta_7 GM_{ni}$
7)	$V_{ni} = ASC_1 + \beta_2 \cdot LC_{ni} + \beta_3 \cdot Pest_{ni} + \beta_4 \cdot Info_{ni} + \beta_5 \cdot price + \beta_6 \cdot price^2 + \beta_7 \log(GM_{ni})$
8)	$V_{ni} = ASC_1 + \beta_2 \cdot LC_{ni} + \beta_3 \cdot Pest_{ni} + \beta_4 \cdot Info_{ni} + \beta_5 \cdot price + \beta_6 \cdot price^2 + \beta_7 GM0_{ni} + \beta_7 GM1_{ni} + \beta_9 GM5_{ni}$
9)	$V_{ni} = ASC_1 + \beta_2 \cdot LC_{ni} + \beta_3 \cdot Pest_{ni} + \beta_4 \cdot Info_{ni} + \beta_5 \cdot price + \beta_6 \cdot price^2 + \beta_7 NonGM_{ni} + \beta_8 GMCont_{ni}$
10)	$V_{ni} = ASC_1 + \beta_2 \cdot LC_{ni} + \beta_3 \cdot Pest_{ni} + \beta_4 \cdot Info_{ni} + \beta_5 \cdot price + \beta_6 \cdot price^2 + \beta_7 NonGM_{ni} + \beta_8 \log(GMCont_{ni})$

Table 3.5. Test of hypothesis for deciding on specification for indirect utility function of MN logit model

Hypothesis Testes*	Test Statistic	Result
(1) Vs. (2)	Higher Log- Likelihood value criterion	Reject (1)
(1) Vs. (3)	Swait and Louviere Log- Likelihood test	Reject (1)
(3) Vs. (2)	Swait and Louviere Log- Likelihood test	Cannot reject (3)
(3) Vs. (4)	Swait and Louviere Log- Likelihood test	Reject (3)
(4) Vs (5)	Higher Log- Likelihood value criterion	Cannot Reject (4)
(6) Vs. (7)	Higher Log- Likelihood value criterion	Reject (6)
(6) Vs (8)	Swait and Louviere Log- Likelihood test	Reject (6)
(8) Vs. (7)	Swait and Louviere Log- Likelihood test	Cannot reject (8)
(8) Vs. (9)	Swait and Louviere Log- Likelihood test	Reject (8)
(9) Vs. (10)	Higher Log- Likelihood value criterion	Cannot reject (9)
(1) Vs. (6)	Swait and Louviere Log- Likelihood test	Cannot Reject (1)
(2) Vs. (7)	Swait and Louviere Log- Likelihood test	Cannot Reject (2)
(3) Vs. (8)	Swait and Louviere Log- Likelihood test	Cannot Reject (3)
(4) Vs (9)	Swait and Louviere Log- Likelihood test	Cannot Reject (4)
(5) Vs. (10)	Swait and Louviere Log- Likelihood test	Cannot Reject (5)

**Numbers refer to the specifications in Table 3.4*

Table 3.6. Multinomial Logit model: with and without individual characteristics

	Basic MN logit				MN logit with individual characteristics			
	Coefficient	Std. Error	t-Stat	P-Value	Coefficient	Std. Error	t-Stat	P-Value
ASCS1	-0.124	0.130	-0.952	0.341	0.128	0.137	0.934	0.350
Living condition	0.808	0.047	17.293	0.000	0.940	0.056	16.770	0.000
Pesticides	0.310	0.040	7.733	0.000	0.464	0.045	10.317	0.000
NonGM	0.945	0.101	9.343	0.000	1.172	0.112	10.455	0.000
GMCont	-0.013	0.004	-3.226	0.001	-0.044	0.007	-6.436	0.000
Information	0.098	0.038	2.543	0.011	0.134	0.045	2.996	0.003
Price	-0.909	0.137	-6.621	0.000	-1.445	0.146	-9.896	0.000
					-	-	-	-
LC*Ethical resistance	-	-	-	-	-0.061	0.054	-1.131	0.258
Pes*Ethical resistance	-	-	-	-	0.156	0.043	3.627	0.000
NonGM *Ethical	-	-	-	-	0.905	0.113	7.981	0.000
GMCont*Ethical	-	-	-	-	-0.040	0.006	-6.888	0.000
Inf*Ethical resistance	-	-	-	-	0.071	0.044	1.590	0.112
Price*Ethical resistance	-	-	-	-	-0.678	0.096	-7.091	0.000
	-	-	-	-	-	-	-	-
LC*Mistrust and disbelief	-	-	-	-	0.152	0.056	2.702	0.007
Pes*Mistrust and	-	-	-	-	0.262	0.046	5.647	0.000
NonGM *Mistrust and	-	-	-	-	0.802	0.121	6.638	0.000
GMCont*Mistrust and	-	-	-	-	-0.014	0.005	-2.698	0.007
Inf*Mistrust and disbelief	-	-	-	-	0.055	0.047	1.156	0.248
Price*Mistrust and	-	-	-	-	-0.695	0.100	-6.939	0.000
	-	-	-	-	-	-	-	-
LC*Environment	-	-	-	-	0.315	0.061	5.168	0.000
Pes*Environment	-	-	-	-	0.129	0.047	2.721	0.007
NonGM *Environment	-	-	-	-	0.273	0.127	2.153	0.031
GMCont*Environment	-	-	-	-	-0.021	0.005	-4.145	0.000
Inf*Environment	-	-	-	-	-0.020	0.049	-0.418	0.676
Price*Environment	-	-	-	-	-0.357	0.107	-3.352	0.001
	-	-	-	-	-	-	-	-
LC*Cost and bargain	-	-	-	-	-0.155	0.058	-2.653	0.008
Pes*Cost and bargain	-	-	-	-	-0.117	0.049	-2.382	0.017
NonGM *Cost and	-	-	-	-	0.081	0.127	0.643	0.520
GMCont*Cost and	-	-	-	-	0.011	0.005	2.000	0.046
Inf*Cost and bargain	-	-	-	-	-0.112	0.051	-2.201	0.028
Price*Cost and bargain	-	-	-	-	-0.067	0.105	-0.637	0.524
	-	-	-	-	-	-	-	-
LC*Food safety concerns	-	-	-	-	-0.134	0.058	-2.335	0.020
Pes*Food safety concerns	-	-	-	-	-0.152	0.049	-3.118	0.002
NonGM *Food safety	-	-	-	-	-0.302	0.128	-2.362	0.018
GMCont*Food safety	-	-	-	-	0.009	0.005	1.805	0.071
Inf*Food safety concerns	-	-	-	-	-0.061	0.051	-1.208	0.227
Price*Food safety	-	-	-	-	0.301	0.105	2.864	0.004
Log of Likelihood	-2084.4501				-1800.02			
Number of Observations	1753				1753			

Table 3.7. Two Latent Segment Model

	Coeff	Std. Error	t-Stat	P-Value
Segment 2: segment function coefficients				
Constant2	1.026	0.107	9.561	0.000
Ethical resistance	1.634	0.118	13.799	0.000
Mistrust and disbelief	1.432	0.131	10.971	0.000
Environment concerns	0.664	0.128	5.180	0.000
Cost and bargain concerns	-0.056	0.121	-0.463	0.644
Food safety concerns	1.081	0.141	7.687	0.000
Dummy Education	-0.664	0.181	-3.664	0.000
Log Income	-0.129	0.062	-2.072	0.038
Segment 1: utility function coefficients				
ASCS1	2.432	0.254	9.582	0.000
Living condition	0.757	0.061	12.446	0.000
Pesticides	0.154	0.050	3.108	0.002
NonGM	-0.269	0.156	-1.722	0.085
GMCont	-0.019	0.005	-3.816	0.000
Information	0.008	0.050	0.161	0.872
Price	-1.576	0.195	-8.063	0.000
Segment 2: utility function coefficients				
ASCS1	-3.970	0.223	-17.837	0.000
Living condition	0.866	0.137	6.325	0.000
Pesticides	1.015	0.090	11.317	0.000
NonGM	4.146	0.235	17.637	0.000
GMCont	-3.815	0.061	-62.858	0.000
Information	0.505	0.140	3.611	0.000
Price	-0.820	0.414	-1.981	0.048
Log of Likelihood		-1731.5710		
Number of Observations		1753		

Table 3.8. Three Latent Segment Model

Variable	Coeff	Std. Error	t-Stat	P-Value	
Segment 2: segment function coefficients					
Constant2	-0.315	0.131	-2.411	0.016	**Food Cautious**
Ethical resistance	1.616	0.151	10.707	0.000	
Mistrust and disbelief	1.728	0.200	8.638	0.000	
Environment concerns	0.686	0.148	4.637	0.000	
Cost and bargain concerns	-0.429	0.147	-2.917	0.004	
Food safety concerns	1.637	0.207	7.890	0.000	
Dummy Education	-1.219	0.243	-5.005	0.000	
Log Income	0.189	0.055	3.424	0.001	
Segment 3: segment function coefficients					
Constant2	-4.387	0.242	-18.151	0.000	**Ethical Opponents**
Ethical resistance	4.294	0.815	5.272	0.000	
Mistrust and disbelief	1.294	0.399	3.241	0.001	
Environment concerns	-1.898	0.548	-3.463	0.001	
Cost and bargain concerns	2.586	0.513	5.044	0.000	
Food safety concerns	-0.766	0.399	-1.923	0.055	
Dummy Education	3.870	0.795	4.866	0.000	
Log Income	-1.149	0.341	-3.366	0.001	
Segment 1: utility function coefficients					
ASCS1	2.106	0.231	9.115	0.000	**Food Optimists**
Living condition	0.755	0.056	13.442	0.000	
Pesticides	0.163	0.049	3.353	0.001	
NonGM	-0.141	0.136	-1.040	0.298	
GMCont	-0.017	0.005	-3.699	0.000	
Information	0.012	0.047	0.254	0.799	
Price	-1.464	0.186	-7.873	0.000	
Segment 2: utility function coefficients					
ASCS2	-5.611	0.164	-34.309	0.000	**Food Cautious**
Living condition	8.105	0.273	29.685	0.000	
Pesticides	3.241	0.426	7.601	0.000	
NonGM	2.054	0.682	3.014	0.003	
GMCont	-3.471	0.752	-4.618	0.000	
Information	2.228	0.257	8.658	0.000	
Price	-5.718	0.490	-11.670	0.000	
Segment 3: utility function coefficients					
ASCS3	2.636	0.858	3.071	0.002	**Ethical Opponents**
Living condition	0.010	0.284	0.036	0.971	
Pesticides	1.316	0.508	2.589	0.010	
NonGM	3.324	1.152	2.886	0.004	
GMCont	-2.312	0.636	-3.636	0.000	
Information	0.788	0.370	2.129	0.033	
Price	-5.679	1.829	-3.104	0.002	
Log of Likelihood			-1653.5777		
Number of Observations			1753		

Table 3.9 Four Latent Segment Model

Variable	Coeff	Std. Error	t-Stat	P-Value
Segment 2: segment function coefficients				
Constant2	35.945	13.115	2.741	0.006
Ethical resistance	-6.584	2.281	-2.886	0.004
Mistrust and disbelief	3.720	1.947	1.911	0.056
Environment concerns	12.392	4.289	2.890	0.004
Cost and bargain concerns	8.205	3.321	2.471	0.014
Food safety concerns	0.527	1.467	0.359	0.720
Dummy Education	-13.949	1.166	-11.958	0.000
Log Income	-16.208	6.077	-2.667	0.008
Segment 3: segment function coefficients				
Constant3	-2.813	3.535	-0.796	0.426
Ethical resistance	1.818	0.942	1.931	0.054
Mistrust and disbelief	-0.821	0.480	-1.710	0.087
Environment concerns	-2.332	0.550	-4.242	0.000
Cost and bargain concerns	3.116	0.641	4.858	0.000
Food safety concerns	-2.556	0.486	-5.257	0.000
Dummy Education	5.051	0.992	5.091	0.000
Log Income	-1.421	1.079	-1.316	0.188
Segment 4: segment function coefficients				
Constant4	2.096	1.866	1.123	0.262
Ethical resistance	-1.980	0.274	-7.239	0.000
Mistrust and disbelief	-2.019	0.342	-5.901	0.000
Environment concerns	-0.467	0.197	-2.375	0.018
Cost and bargain concerns	0.649	0.201	3.222	0.001
Food safety concerns	-1.988	0.382	-5.209	0.000
Dummy Education	1.318	0.398	3.316	0.001
Log Income	-0.631	0.527	-1.197	0.232
Segment 1: utility function coefficients				
ASCS1	-6.859	0.315	-21.800	0.000
Living condition	13.142	0.315	41.753	0.000
Pesticides	3.722	0.381	9.764	0.000
NonGM	0.396	0.501	0.790	0.430
GMCont	-5.057	0.737	-6.859	0.000
Information	2.963	0.250	11.848	0.000
Price	-8.044	0.330	-24.355	0.000
Segment 2: utility function coefficients				
ASCS2	-6.022	0.823	-7.319	0.000
Living condition	0.667	0.371	1.799	0.072
Pesticides	6.789	0.587	11.558	0.000
NonGM	13.109	0.344	38.096	0.000
GMCont	-0.450	0.350	-1.286	0.199
Information	0.336	0.365	0.919	0.358
Price	-1.594	0.860	-1.855	0.064
Segment 3: utility function coefficient				
ASCS3	3.354	0.863	3.885	0.000
Living condition	-0.073	0.440	-0.166	0.868
Pesticides	1.427	0.554	2.577	0.010
NonGM	3.061	0.998	3.067	0.002
GMCont	-2.796	0.678	-4.125	0.000
Information	0.830	0.356	2.332	0.020
Price	-5.968	1.629	-3.664	0.000
Segment 4: utility function coefficients				
ASCS4	1.935	0.276	7.004	0.000
Living condition	0.773	0.059	13.134	0.000
Pesticides	0.154	0.050	3.066	0.002
NonGM	-0.208	0.148	-1.405	0.160
GMCont	-0.016	0.005	-3.345	0.001
Information	-0.004	0.048	-0.085	0.932
Price	-1.466	0.190	-7.732	0.000
Log of Likelihood		-1620.3614		
Number of Observations		1753		

Table 3.10 Five Latent Segment Model

Variable	Coeff	Std. Error	t-Stat	P-Value
Segment 2: segment function coefficients				
Constant2	21.467	5.380	3.990	0.000
Ethical resistance	-7.306	1.498	-4.877	0.000
Mistrust and disbelief	-7.879	1.879	-4.194	0.000
Environment concerns	1.879	0.667	2.818	0.005
Cost and bargain concerns	3.915	0.801	4.886	0.000
Food safety concerns	-11.173	2.283	-4.893	0.000
Dummy Education	-13.170	6.760	-1.948	0.052
Log Income	-3.604	1.491	-2.417	0.016
Segment 3: segment function coefficients				
Constant3	-118.326	304.323	-0.389	0.697
Ethical resistance	0.702	1.280	0.549	0.583
Mistrust and disbelief	-5.357	1.620	-3.307	0.001
Environment concerns	-7.183	1.677	-4.283	0.000
Cost and bargain concerns	14.816	2.871	5.160	0.000
Food safety concerns	-8.753	1.904	-4.598	0.000
Dummy Education	101.245	302.363	0.335	0.738
Log Income	5.875	3.107	1.890	0.059
Segment 4: segment function coefficients				
Constant4	21.921	5.448	4.024	0.000
Ethical resistance	-8.166	1.490	-5.481	0.000
Mistrust and disbelief	-9.327	1.870	-4.987	0.000
Environment concerns	0.044	0.582	0.076	0.939
Cost and bargain concerns	3.638	0.802	4.536	0.000
Food safety concerns	-11.138	2.262	-4.923	0.000
Dummy Education	1.351	0.937	1.441	0.150
Log Income	-3.660	1.491	-2.454	0.014
Segment 5: segment function coefficients				
Constant5	23.290	9.216	2.527	0.012
Ethical resistance	0.888	2.323	0.382	0.702
Mistrust and disbelief	-9.678	2.006	-4.825	0.000
Environment concerns	-0.726	0.717	-1.012	0.312
Cost and bargain concerns	5.835	1.199	4.865	0.000
Food safety concerns	-13.515	2.468	-5.475	0.000
Dummy Education	6.734	1.994	3.377	0.001
Log Income	-8.875	3.120	-2.845	0.004
Segment 1: utility function coefficients				
ASCS1	-11.712	21.530	-0.544	0.587
Living condition	20.481	32.993	0.621	0.535
Pesticides	3.478	0.744	4.674	0.000
NonGM	-4.569	11.900	-0.384	0.701
GMCont	-11.300	14.841	-0.761	0.446
Information	2.517	0.650	3.874	0.000
Price	-5.891	2.305	-2.556	0.011
Segment 2: utility function coefficients				
ASCS2	0.651	1.149	0.567	0.571
Living condition	0.654	0.410	1.593	0.111
Pesticides	6.084	2.900	2.098	0.036
NonGM	5.425	2.502	2.168	0.030
GMCont	-6.373	3.344	-1.906	0.057
Information	0.192	0.300	0.641	0.521
Price	-2.133	1.572	-1.357	0.175
Segment 3: utility function coefficient				
ASCS3	3.958	7.672	0.516	0.606
Living condition	1.177	0.306	3.847	0.000
Pesticides	0.241	0.276	0.873	0.383
NonGM	-0.856	7.707	-0.111	0.912
GMCont	-4.381	7.664	-0.572	0.568
Information	0.231	0.227	1.016	0.310
Price	-1.948	0.866	-2.251	0.025
Segment 4: utility function coefficients				
ASCS4	1.694	0.192	8.808	0.000
Living condition	0.794	0.059	13.503	0.000
Pesticides	0.172	0.050	3.457	0.001
NonGM	-0.174	0.136	-1.281	0.200
GMCont	-0.014	0.005	-2.797	0.005
Information	0.005	0.049	0.094	0.925
Price	-1.491	0.185	-8.049	0.000
Segment 4: utility function coefficients				
ASCS5	-2.277	13.732	-0.166	0.868
Living condition	-4.889	14.465	-0.338	0.735
Pesticides	8.771	23.817	0.368	0.713
NonGM	18.759	31.909	0.588	0.557
GMCont	-24.766	23.144	-1.070	0.285
Information	67.071	147.920	0.453	0.650
Price	-90.080	217.660	-0.414	0.679
Log of Likelihood		-1587.8720		
Number of Observations		1753		

Table 3.11. Criteria for determining optimal number of segments

Number of segments	Parameters (P)	Logarithm Likelihood (LL)	ρ bar2	AIC	BIC
1	8	-2084.45	0.139	4184.90	2106.37
2	24	-1737.29	0.275	3522.57	1803.05
3	40	-1653.58	0.303	3387.15	1763.19
4	56	-1620.35	0.310	3352.71	1773.81
5	72	-1587.87	0.315	3319.74	1785.18

1) N=240 individuals
2) AIC (Akaike Information Criterion) is -2(LL-P).
3) ρ bar2 = {1-AIC/2LL(0)}
4) BIC(Bayesian Information Criterion) is -LL+(P/2)*ln(N).

Table 3.12. Random Parameter Logit model

Variable	Coefficient	Standard Error	t-stat	p-value
	Random parameters in utility functions (mean values)			
ASC	-2.144	0.586	-3.661	0.000
Living condition	0.828	0.047	17.458	0.000
Pesticides	0.336	0.041	8.224	0.000
NonGM	0.987	0.103	9.569	0.000
GMCont	-0.014	0.004	-3.323	0.001
Information	0.092	0.039	2.378	0.017
Price	-0.884	0.141	-6.279	0.000
	Non-random parameters in utility functions			
Ethical resistance	-0.612	0.064	-9.588	0.000
Mistrust and disbelief	-0.415	0.069	-5.994	0.000
Environment concerns	-0.212	0.075	-2.818	0.005
Cost and bargain concerns	-0.011	0.073	-0.153	0.878
Food safety concerns	-0.281	0.074	-3.772	0.000
Education dummy	0.417	0.122	3.431	0.001
Income (logs)	0.233	0.076	3.052	0.002
	Derived standard deviations of parameter distributions			
SD_ASC	0.008	0.058	0.139	0.890
SD_Living condition	0.010	0.038	0.267	0.790
SD_Pesticides	0.001	0.035	0.035	0.972
SD_NonGM	0.001	0.059	0.015	0.988
SD_GMCont	0.000	0.003	0.039	0.969
SD_Information	0.003	0.034	0.076	0.940
SD_Price	0.010	0.049	0.205	0.838
Log likelihood function		-1980.643		
Replications for simulated probabilities		500		
Number of observations		1753		

Table 3.13. The CovHet Model

Variable	Coeff	Std. Error	t-Stat	P-Value
		Utility Parameters		
ASC	0.032	0.175	0.184	0.854
Living condition	0.791	0.063	12.494	0.000
Pesticides	0.271	0.041	6.641	0.000
NonGM	1.022	0.107	9.555	0.000
GMCont	-0.013	0.005	-2.491	0.013
Information	0.082	0.046	1.780	0.075
Price	-0.999	0.186	-5.379	0.000
		Covariates of scale function		
Constant	0.944	0.107	8.829	0.000
Ethical resistance	0.844	0.107	7.857	0.000
Mistrust and disbelief	0.255	0.114	2.241	0.025
Environment concerns	-0.151	0.100	-1.519	0.129
Cost and bargain concerns	-1.005	0.144	-6.987	0.000
Food safety concerns	0.272	0.127	2.133	0.033
Log Income	0.944	0.107	8.829	0.000
Dummy Education	-0.222	0.183	-1.215	0.224
Log-Likelihood		-1931.015		
Chi-squared		998.3176		
Sample Size		1753		

Table 3.14 Part-worth values for alternative multinomial choice models

	MN logit model				Three Segment LS Model								RP Logit Model		CovHet Model	
	Model without individual Characteristics		Model with individual Characteristics		Food Optimist Segment		Food Cautious Segment		Ethical Opponent Segment		Single weighted estimate from 3-segment model		Model with individual Characteristics		Model with individual Characteristics	
	£	**Rank**	**£**	**Rank**	**£**	**Rank**	**£**	**Rank**	**£**	**Rank**	**£**	**Rank**	**£**	**Rank**	**£**	**Rank**
Living conditions[a]	0.89	**(2)**	0.65	**(2)**	0.516	**(1)**	1.417	**(1)**	0.002	**(5)**	0.826	**(1)**	0.937	**(2)**	0.791	**(2)**
Pesticides[b]	0.34	**(3)**	0.32	**(3)**	0.111	**(2)**	0.567	**(3)**	0.232	**(3)**	0.714	**(2)**	0.380	**(3)**	0.271	**(3)**
NonGM[c]	1.04	**(1)**	0.81	**(1)**	-0.096	**(3)**	0.359	**(5)**	0.585	**(1)**	0.366	**(3)**	1.117	**(1)**	1.022	**(1)**
GMCont[d]	-0.01	**(5)**	-0.03	**(5)**	-0.012	**(4)**	-0.607	**(2)**	-0.407	**(2)**	-0.273	**(4)**	-0.016	**(5)**	-0.013	**(5)**
Information[e]	0.11	**(4)**	0.09	**(4)**	0.008	**(5)**	0.390	**(4)**	0.139	**(4)**	0.157	**(5)**	0.104	**(4)**	0.082	**(4)**

Notes:

Bold numbers in parentheses denote implicit ranking of choice attributes.

[a] *Calculated as the marginal WTP to have free range eggs*
[b] *Calculated as the marginal WTP to have organic eggs*
[c] *Calculated as the marginal WTP for reducing GM from 1% to the 0% content level*
[d] *Calculated as the marginal WTP for reducing GM from 30% to the 1% content level*
[e] *Calculated as the marginal WTP to have information (labelling) on egg boxes*

3.15. Appendix 2: Maximum likelihood codes

GaussX code for Latent Segment model (four segment case):

```
??INPUT DATA
create 1 2496;
open (d) Number Type1 Choice Egg  AltA1 AltA2 AltA3 AltA4 AltA5
                  AltB1 AltB2 AltB3 AltB4 AltB5 AltC1 AltC2 AltC3 AltC4 AltC5
                  AltD1 AltD2 AltD3 AltD4 AltD5 Q24 Q24OTHER Q1First
                  Q2 Q3A Q3B Q3C Q3D Q5 Q5b Q8a Q8b Q8c Q8d Q8e Q9
                  Q10  Q26Sex Q27Age Q28 Q29 Q32  Q33 Date1
                  af1 af2 af3 af4 af5 bf1 bf2 bf3 bf4
                  cf1 cf2 cf3 fd1 fd2 fd3 fd4;
            fname=LSMdt10c.XLS;


?? Sort out data
genr select=(choice.>0.5);
smpl select;

GENR Opt1=(Choice.==1);
GENR Opt2=(Choice.==2);
GENR Opt3=(Choice.==3);
GENR Opt4=(Choice.==4);


GENR PRICEA=ALTA5./100;
GENR PRICEB=ALTB5./100;
GENR PRICEC=ALTC5./100;

GENR NONGMA=(altA3.==0); ?-1*(1-(altA3.==0));
GENR NONGMB=(altB3.==0); ?-1*(1-(altB3.==0));
GENR NONGMC=(altC3.==0); ?-1*(1-(altC3.==0));

GENR GMCONTA=altA3;GENR GMCONTB=altB3;GENR GMCONTC=altC3;

GENR DAGE=(Q27AGE.>0);
GENR LABEL=(Q8e.==5);
GENR FEML=(Q26SEX.>1.5);
GENR CHILD=(Q29.>0.5);
GENR FECHILD=CHILD.*FEML;
GENR CEGG=LOG(Q10);
GENR Q27=Q27AGE;
GENR
AGE=21.*(Q27.==1)+30.*(Q27.==2)+40.*(Q27.==3)+50.*(Q27.==4)+60.*(Q27.==5)

+70.*(Q27.==6)+80.*(Q27.==7)+90.*(Q27.==8)+97.*(Q27.==9)+50.*(Q27.==0)
      +50.*(Q27.==99);
GENR LAGE=LN(AGE);
GENR INC=400.*(Q33.==1)+750.*(Q33.==2)+1250.*(Q33.==3)+1750.*(Q33.==4)
     +2250.*(Q33.==5)+2750.*(Q33.==6)+3250.*(Q33.==7)+3750.*(Q33.==8)
     +4250.*(Q33.==9)+4750.*(Q33.==10)+6000.*(Q33.==11)
     +8000.*(Q33.==12)+12000.*(Q33.==13)+16000.*(Q33.==14)
     +1750.*(Q33.==0)+1750.*(Q33.==99);
GENR LINC=LOG(INC);
GENR EDU=Q32+(Q32.==0).*2;
GENR COLL=(q32.>4);
GENR SEX=(Q26SEX.==1);
GENR GMLIKE=((Q3A.>3.5)+(Q3B.>3.5)+(Q3C.>3.5)+(Q3D.>3.5));
```

```
?--------------------------------------------------?
?              Multinominal Logit Model          ?
?---------------------------------------------------?

FRML EU1 U1=(ASCS1+BX1S1*altA1+BX2S1*altA2+BX31S1*NONGMA+BGMCONT*GMCONTA
                     +BX4S1*altA4+BX5S1*altA5);
FRML EU2 U2=(ASCS1+BX1S1*altB1+BX2S1*altB2+BX31S1*NONGMB+BGMCONT*GMCONTB
                     +BX4S1*altB4+BX5S1*altB5);
FRML EU3 U3=(ASCS1+BX1S1*altC1+BX2S1*altC2+BX31S1*NONGMC+BGMCONT*GMCONTC
                     +BX4S1*altC4+BX5S1*altC5);
FRML EU4 U4=0;

FRML CNL1 llfn=Opt1.*u1+Opt2.*u2+Opt3.*U3+Opt4.*0-
ln(exp(U1)+exp(U2)+exp(U3)+1);

PARAM  ASCS1  BX1S1 BX2S1 BX31S1 BGMCONT BX4S1 BX5S1; Value=1 1 1 1   -.01 1
0;
ML EU1 EU2 EU3 EU4 CNL1;
METHOD= BHHH BFGS BFGS;
```

```
?---------------------------------------------------?
?              TWO SEGMENT MODEL                    ?
?---------------------------------------------------?

?? setting starting values

PARAM CON2   RZ21  RZ22  RZ23  RZ24   RZ25   BEDU2  BINC2;
Value= -.3   1.6    2     .7    -.4   1.6    -1.2   0.18 ;


PARAM ASCS1  LCS1 PESTS1   NONGMS1  GMCONTS1  INFS1  PRICES1;
Value= 2.1    .75    .15      0         0.02     0.01  -1.4  ;
PARAM ASCS2  LCS2 PESTS2    NONGMS2  GMCONTS2  INFS2  PRICES2;
Value=-5.6    8.1     3       2.0       -3.4     2.2   -5.7  ;


FRML ES2  S2= exp(CON2 +BINC2*LINC +BEDU2*COLL
                 +RZ21*AF1+RZ22*AF2+RZ23*AF3+RZ24*AF4-RZ25*AF5);


FRML E1S1 U11=exp(ASCS1+LCS1*altA1+PESTS1*altA2
               +NONGMS1*NONGMA+GMCONTS1*GMCONTA+INFS1*altA4+PRICES1*PRICEA);
FRML E1S2 U12=exp(ASCS2+LCS2*altA1+PESTS2*altA2
               +NONGMS2*NONGMA+GMCONTS2*GMCONTA+INFS2*altA4+PRICES2*PRICEA);

FRML E2S1 U21=exp(ASCS1+LCS1*altB1+PESTS1*altB2
              +NONGMS1*NONGMB+GMCONTS1*GMCONTB+INFS1*altB4+PRICES1*PRICEB);
FRML E2S2 U22=exp(ASCS2+LCS2*altB1+PESTS2*altB2
              +NONGMS2*NONGMB+GMCONTS2*GMCONTB+INFS2*altB4+PRICES2*PRICEB);

FRML E3S1 U31=exp(ASCS1+LCS1*altC1+PESTS1*altC2
              +NONGMS1*NONGMC+GMCONTS1*GMCONTC+INFS1*altC4+PRICES1*PRICEC);
FRML E3S2 U32=exp(ASCS2+LCS2*altC1+PESTS2*altC2
              +NONGMS2*NONGMC+GMCONTS2*GMCONTC+INFS2*altC4+PRICES2*PRICEC);

FRML E4S1 U41=1;
FRML E4S2 U42=1;

FRML E1    U1=U11+U21+U31+U41;
FRML E2    U2=U12+U22+U32+U42;

FRML LSM llfn=Opt1.*(ln(U11./U1+S2.*(U12./U2)))
              +Opt2.*(ln(U21./U1+S2.*(U22./U2)))
              +Opt3.*(ln(U31./U1+S2.*(U32./U2)))
              +Opt4.*(ln(U41./U1+S2.*(U42./U2)))
              -ln(1+S2+S3)  ;


ML (i,d)  ES2 E1S1 E1S2 E2S1 E2S2
          E3S1 E3S2 E4S1 E4S2 E1 E2 LSM ;

METHOD= BFGS  BFGS BFGS;
MAXIT=10000;
TOL=0.001;

? MARKET SHARE
GENR SEG2=exp(CON2 +BEDU2*COLL+BINC2*LINC
                 +RZ21*AF1+RZ22*AF2+RZ23*AF3+RZ24*AF4-RZ25*AF5);

GENR SUMSEG=1+SEG2;
GENR PROB1=1./SUMSEG;
GENR PROB2=SEG2./SUMSEG;

COVA (d,c) PROB1 PROB2 PROB3;
end;
```

```
?-------------------------------------------------?
?             THREE SEGMENT MODEL              ?
?-------------------------------------------------?

?? setting starting values

PARAM CON2   RZ21  RZ22  RZ23  RZ24   RZ25   BEDU2  BINC2;
Value= -.3   1.6    2    .7    -.4    1.6    -1.2   0.18 ;
PARAM CON3   RZ31  RZ32  RZ33  RZ34  RZ35  BEDU3 BINC3;
Value= -4.3    4     1   -2     2.5    -.8    4   -1;

PARAM ASCS1  LCS1 PESTS1   NONGMS1  GMCONTS1  INFS1  PRICES1;
Value= 2.1    .75    .15      0          0.02      0.01  -1.4  ;
PARAM ASCS2  LCS2 PESTS2    NONGMS2  GMCONTS2  INFS2  PRICES2;
Value=-5.6    8.1     3       2.0        -3.4      2.2   -5.7  ;
PARAM ASCS3  LCS3 PESTS3   NONGMS3  GMCONTS3  INFS3  PRICES3 ;
Value= 2.6   0.01    1.3      3.3        -2.3      .8    -6    ;

FRML ES2  S2= exp(CON2 +BINC2*LINC +BEDU2*COLL
                 +RZ21*AF1+RZ22*AF2+RZ23*AF3+RZ24*AF4-RZ25*AF5);
FRML ES3  S3= exp(CON3 +BINC3*LINC +BEDU3*COLL
                 +RZ31*AF1+RZ32*AF2+RZ33*AF3+RZ34*AF4-RZ35*AF5);


FRML E1S1 U11=exp(ASCS1+LCS1*altA1+PESTS1*altA2
              +NONGMS1*NONGMA+GMCONTS1*GMCONTA+INFS1*altA4+PRICES1*PRICEA);
FRML E1S2 U12=exp(ASCS2+LCS2*altA1+PESTS2*altA2
              +NONGMS2*NONGMA+GMCONTS2*GMCONTA+INFS2*altA4+PRICES2*PRICEA);
FRML E1S3 U13=exp(ASCS3+LCS3*altA1+PESTS3*altA2
              +NONGMS3*NONGMA+GMCONTS3*GMCONTA+INFS3*altA4+PRICES3*PRICEA);

FRML E2S1 U21=exp(ASCS1+LCS1*altB1+PESTS1*altB2
             +NONGMS1*NONGMB+GMCONTS1*GMCONTB+INFS1*altB4+PRICES1*PRICEB);
FRML E2S2 U22=exp(ASCS2+LCS2*altB1+PESTS2*altB2
             +NONGMS2*NONGMB+GMCONTS2*GMCONTB+INFS2*altB4+PRICES2*PRICEB);
FRML E2S3 U23=exp(ASCS3+LCS3*altB1+PESTS3*altB2
             +NONGMS3*NONGMB+GMCONTS3*GMCONTB+INFS3*altB4+PRICES3*PRICEB);



FRML E3S1 U31=exp(ASCS1+LCS1*altC1+PESTS1*altC2
             +NONGMS1*NONGMC+GMCONTS1*GMCONTC+INFS1*altC4+PRICES1*PRICEC);
FRML E3S2 U32=exp(ASCS2+LCS2*altC1+PESTS2*altC2
             +NONGMS2*NONGMC+GMCONTS2*GMCONTC+INFS2*altC4+PRICES2*PRICEC);
FRML E3S3 U33=exp(ASCS3+LCS3*altC1+PESTS3*altC2
             +NONGMS3*NONGMC+GMCONTS3*GMCONTC+INFS3*altC4+PRICES3*PRICEC);

FRML E4S1 U41=1;
FRML E4S2 U42=1;
FRML E4S3 U43=1;

FRML E1   U1=U11+U21+U31+U41;
FRML E2   U2=U12+U22+U32+U42;
FRML E3   U3=U13+U23+U33+U43;

FRML LSM llfn=Opt1.*(ln(U11./U1+S2.*(U12./U2)+S3.*(U13./U3)))
             +Opt2.*(ln(U21./U1+S2.*(U22./U2)+S3.*(U23./U3)))
             +Opt3.*(ln(U31./U1+S2.*(U32./U2)+S3.*(U33./U3)))
             +Opt4.*(ln(U41./U1+S2.*(U42./U2)+S3.*(U43./U3)))
             -ln(1+S2+S3) ;

ML (i,d)  ES2 ES3  E1S1 E1S2 E1S3 E2S1 E2S2 E2S3
          E3S1 E3S2 E3S3 E4S1 E4S2 E4S3 E1 E2 E3 LSM ;

METHOD= BFGS  BFGS BFGS;
MAXIT=10000;
TOL=0.001;

? MARKET SHARE
GENR SEG2=exp(CON2 +BEDU2*COLL+BINC2*LINC
                 +RZ21*AF1+RZ22*AF2+RZ23*AF3+RZ24*AF4-RZ25*AF5);
GENR SEG3=exp(CON3 +BEDU3*COLL+BINC3*LINC
```

```
                  +RZ31*AF1+RZ32*AF2+RZ33*AF3+RZ34*AF4-RZ35*AF5);
GENR SUMSEG=1+SEG2+SEG3;
GENR PROB1=1./SUMSEG;
GENR PROB2=SEG2./SUMSEG;
GENR PROB3=SEG3./SUMSEG;

COVA (d,c) PROB1 PROB2 PROB3;
end;
--------------------------------------------------------------
?                        FOUR SEGMENT MODEL
?-------------------------------------------------------------

PARAM CON2    RZ21    RZ22    RZ23   RZ24   RZ25   BEDU2   BINC2;
Value= 0       0       0       0      0      0     0        0  ;
PARAM CON3    RZ31    RZ32    RZ33   RZ34   RZ35    BEDU3 BINC3;
Value= 0       0       0       0      0      0     0        0  ;
PARAM CON4    RZ41    RZ42    RZ43   RZ44   RZ45   BEDU4   BINC4 ;
Value= 0       0       0       0      0      0     0        0  ;


PARAM ASCS1   LCS1 PESTS1 NONGMS1 GMCONTS1   INFS1 PRICES1;
Value= 7        .9  .15       .1     -.01       0.01  -3  ;
PARAM ASCS2   LCS2 PESTS2 NONGMS2 GMCONTS2  INFS2 PRICES2 ;
Value= 2.3      .6     .15    .1      -.1        .2  -1.8 ;
PARAM ASCS3   LCS3 PESTS3 NONGMS3 GMCONTS3  INFS3 PRICES3 ;
Value= -2.7    3.6   2.3     1.8       -.3       1.5  -.35 ;
PARAM ASCS4   LCS4 PESTS4 NONGMS4 GMCONTS4  INFS4 PRICES4 ;
Value= 3.9      .4    1      2.7      -2.2         1  -5   ;


FRML ES2  S2= exp(CON2 +BINC2*LINC +BEDU2*COLL
                  +RZ21*AF1+RZ22*AF2+RZ23*AF3+RZ24*AF4-RZ25*AF5);
FRML ES3  S3= exp(CON3 +BINC3*LINC +BEDU3*COLL
                  +RZ31*AF1+RZ32*AF2+RZ33*AF3+RZ34*AF4-RZ35*AF5);
FRML ES4  S4= exp(CON4 +BINC4*LINC +BEDU4*COLL
                  +RZ41*AF1+RZ42*AF2+RZ43*AF3+RZ44*AF4-RZ45*AF5);

FRML E1S1 U11=exp(ASCS1+LCS1*altA1+PESTS1*altA2
               +NONGMS1*NONGMA+GMCONTS1*GMCONTA+INFS1*altA4+PRICES1*PRICEA);
FRML E1S2 U12=exp(ASCS2+LCS2*altA1+PESTS2*altA2
               +NONGMS2*NONGMA+GMCONTS2*GMCONTA+INFS2*altA4+PRICES2*PRICEA);
FRML E1S3 U13=exp(ASCS3+LCS3*altA1+PESTS3*altA2
               +NONGMS3*NONGMA+GMCONTS3*GMCONTA+INFS3*altA4+PRICES3*PRICEA);
FRML E1S4 U14=exp(ASCS4+LCS4*altA1+PESTS4*altA2
               +NONGMS4*NONGMA+GMCONTS4*GMCONTA+INFS4*altA4+PRICES4*PRICEA);


FRML E2S1 U21=exp(ASCS1+LCS1*altB1+PESTS1*altB2
              +NONGMS1*NONGMB+GMCONTS1*GMCONTB+INFS1*altB4+PRICES1*PRICEB);
FRML E2S2 U22=exp(ASCS2+LCS2*altB1+PESTS2*altB2
              +NONGMS2*NONGMB+GMCONTS2*GMCONTB+INFS2*altB4+PRICES2*PRICEB);
FRML E2S3 U23=exp(ASCS3+LCS3*altB1+PESTS3*altB2
              +NONGMS3*NONGMB+GMCONTS3*GMCONTB+INFS3*altB4+PRICES3*PRICEB);
FRML E2S4 U24=exp(ASCS4+LCS4*altB1+PESTS4*altB2
              +NONGMS4*NONGMB+GMCONTS4*GMCONTB+INFS4*altB4+PRICES4*PRICEB);


FRML E3S1 U31=exp(ASCS1+LCS1*altC1+PESTS1*altC2
             +NONGMS1*NONGMC+GMCONTS1*GMCONTC+INFS1*altC4+PRICES1*PRICEC);
FRML E3S2 U32=exp(ASCS2+LCS2*altC1+PESTS2*altC2
             +NONGMS2*NONGMC+GMCONTS2*GMCONTC+INFS2*altC4+PRICES2*PRICEC);
FRML E3S3 U33=exp(ASCS3+LCS3*altC1+PESTS3*altC2
             +NONGMS3*NONGMC+GMCONTS3*GMCONTC+INFS3*altC4+PRICES3*PRICEC);
FRML E3S4 U34=exp(ASCS4+LCS4*altC1+PESTS4*altC2
             +NONGMS4*NONGMC+GMCONTS4*GMCONTC+INFS4*altC4+PRICES4*PRICEC);


FRML E4S1 U41=1;
FRML E4S2 U42=1;
FRML E4S3 U43=1;
FRML E4S4 U44=1;
```

```
FRML E1    U1=U11+U21+U31+U41;
FRML E2    U2=U12+U22+U32+U42;
FRML E3    U3=U13+U23+U33+U43;
FRML E4    U4=U14+U24+U34+U44;

FRML LSM llfn=Opt1.*(ln(U11./U1+S2.*(U12./U2)+S3.*(U13./U3)+S4.*(U14./U4)))
             +Opt2.*(ln(U21./U1+S2.*(U22./U2)+S3.*(U23./U3)+S4.*(U24./U4)))
             +Opt3.*(ln(U31./U1+S2.*(U32./U2)+S3.*(U33./U3)+S4.*(U34./U4)))
             +Opt4.*(ln(U41./U1+S2.*(U42./U2)+S3.*(U43./U3)+S4.*(U44./U4)))
             -ln(1+S2+S3+S4) ;

ML (i,d)   ES2 ES3 ES4 E1S1 E1S2 E1S3 E1S4 E2S1 E2S2 E2S3 E2S4
           E3S1 E3S2 E3S3 E3S4 E4S1 E4S2 E4S3 E4S4 E1 E2 E3 E4 LSM ;

METHOD= BFGS BFGS BFGS;
MAXIT=10000;
MAXSQZ=30;
TOL=0.001;

? MARKET SHARE
GENR SEG2=exp(CON2 +BINC2*LINC +BEDU2*COLL
                 +RZ21*AF1+RZ22*AF2+RZ23*AF3+RZ24*AF4-RZ25*AF5);
GENR SEG3=exp(CON3 +BINC3*LINC +BEDU3*COLL
                 +RZ31*AF1+RZ32*AF2+RZ33*AF3+RZ34*AF4-RZ35*AF5);
GENR SEG4=exp(CON4 +BINC4*LINC +BEDU4*COLL
                 +RZ41*AF1+RZ42*AF2+RZ43*AF3+RZ44*AF4-RZ45*AF5);

GENR SUMSEG=1+SEG2+SEG3+SEG4;
GENR PROB1=1./SUMSEG;
GENR PROB2=SEG2./SUMSEG;
GENR PROB3=SEG3./SUMSEG;
GENR PROB4=SEG4./SUMSEG;
COVA (d,c) PROB1 PROB2 PROB3 PROB4;
end;
```

LIMDEP code for Random parameter logit model:

```
***INPUT DATA**
RESET;
READ;File=h:\RPMdata2.xls
       ;Nvar=34;Nobs=9985 ;Format=xls ;Names $


CREATE;LC=(A1)$
CREATE;Pest=(A2)$
CREATE;GMcont=A3$
CREATE;NonGM=(A3=0)$
CREATE;Inform=(A4)$
CREATE;Price=A5/100$
CREATE;COLL=(Q32>3)$
CREATE;INC=Q33$     ? Recode of Variable(income)
RECORDE;INC;1=400;2=750;3=1250;4=1750;5=2250;6=2250;
           7=3250;8=3750;9=4250;10=4750;11=6000;
           12=8000;13=12000;14=16000;0=1750$
CREATE;LINC=LOG(INC)$
CREATE;MAF5=-AF5 $
REJECT; CHOICE<-10$


?==================================================?
?         Randam Parameter Model                   ?
?==================================================?

DISCRETE CHOICE
        ;Lhs=Choice,NIJ ,ALTij
        ;Choices=opt1,opt2,opt3,opt4
        ;RPL = ASC, BLC,BPEST,BIMFORM,BPRICE,BNONGM,BGMCONT,
            ? BF1,AF2,BF3,BF4,BF5, BEUD, BINC  ? excluded from RPs

        ;Pts=500
        ;Fcn=
```

```
        ASC(N),BLC(N),BPEST(N),BIMFORM(N),BPRICE(N),BNONGM(N),BGMCONT(N),
              ? BF1(N),BF2(N),BF3(N),BF4(N),BF5(N) ? excluded from RPs
               BEDU(N),BINC(N)
         ;Model:
          U(opt1,opt2,opt3)=ASC+BLC*LC+BPEST*PEST+BGMCONT*GMCONT+BNONGM*NONGM
                            +BIMFORM*INFORM+BPRICE*PRICE
                            +BF1*AF1+BF2*AF2+BF3*AF3+BF4*AF4+BF5*MAF5
                            +BEDU*COLL+BINC*LINC /
          U(opt4)=0$
STOP$
END$
```

LIMDEP code for CovHet model:

```
***INPUT DATA AS IN LP MODEL***

?-----------------------------------
?  Covariate Heterogenity Model
?-----------------------------------
NLOGIT
         ;Lhs=Choice,NIJ ,ALTij
         ;Choices=opt1,opt2,opt3,opt4
         ;Hfn=AF1, AF2, AF3, AF4, AF5, LINC, COLL
         ;tree=(opt1,opt2),(opt3,opt4)
          ;Model:
          U(opt1,opt2,opt3)=ASC+BLC*LC+BPEST*PEST+BGMCONT*GMCONT+BNONGM*NONGM
                            +BIMFORM*INFORM+BPRICE*PRICE/
          U(opt4)=0$

STOP$
END$
```

CHAPTER 4

Accounting for Zero WTP in Open-Ended Type Contingent Valuation Data: An Application of a Generalised Limited Dependent Variable Model

CHAPTER 4

Accounting for Zero WTP in Open-Ended Type Contingent Valuation Data: An Application of a Generalised Limited Dependent Variable Model

4.1. Introduction

Contingent valuation willingness to pay (WTP) data obtained from open-ended type elicitation formats has frequently been found to contain a substantial proportion of zero responses (Carson, 2000). Inappropriate treatment of non-trivial proportions of zero bids can affect the validity and unbiasness of the estimates derived from parametric models of WTP (e.g. expected WTP and elasticity estimates) (Green, 1997). Limited dependent variable (LDV) models are most appropriate for dealing with situations where the data contains a substantial proportion of zero observations on the dependent variable (Blundell and Meghir, 1987). As a result such models have been quite extensively used to analyse OE-type WTP data (e.g. Maguire *et al.,* forthcoming 2003; Mourato, Kontoleon and Danchev, 2002; Brown and Taylor, 2000; Donaldson *et al.,* 1998). Yet, zero WTP responses are not qualitatively the same nor are all LDV models equally suitable in dealing with all forms of zeros. Reported zero WTP values may represent abstentions (the individual is not in the market), corner solutions (e.g. the individual is in the market but cannot afford the good) or misreported zeros (the individual is in the market but for some reason (e.g. strategic bidding) reports a zero WTP). Correct identification and classification of these zeros is required for selecting the appropriate econometric model. Some LDV models are better suited to deal with abstentions, others with corner solutions while others with misreported values (Pudney, 1989; Garcia and Labeaga, 1996; Jones, 1989).

Following Blundell and Meghir (1987) the current chapter presents a generalised limited dependent variable model that allows the data itself to suggest the most appropriate econometric specification for accounting for zero WTP observations.[1] This approach involves

[1] The earlier work by Maddala (1983) and Amemiya (1984) offered the important contributions of systematising the LDV literature. Blundell and Meghir (1987) provided an important extension to this work by exposing the interactions between LDV as well as discussing their behavioural underpinnings. Their work stressed that not all

estimating a series of interrelated models that account for zeros in different ways and imply different data generating processes. Then, and after testing and accounting for heteroscedasticity and non-normality, nested and non-nested tests between competing models would suggest the most suitable specification for each case. This econometric approach may be more permissive and less arbitrary than other commonly used practices in dealing with zero WTP observations in that it does not exclude any observations (such as 'protest') and it does not impose any *a priori* behavioural restrictions.

4.2. Application of limited dependent variable models to the analysis of OE-type WTP data.

Application of LDV models to the analysis of CV data is by no means novel.[2] Past applications have used variants of Tobit and selectivity models. The common structure of these applications is to formulate some type of mixture model that consist of two main components. The first component treats the zero WTP responses as reflecting a discrete choice while the second component treats the non-zero WTP responses as reflecting a continuous choice. The current chapter provides a contribution to the literature on the analysis of OE-type WTP data by presenting a generalised limited dependent variable modelling approach. The aim is to address some of the shortcoming of previous applications of LDV models found in the CV literature.

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zero responses of the dependent variables are qualitatively the same and hence appropriate models must be used to account for all the information contained in the data and avoid biased estimates. In doing so they provided the foundations for all subsequent work that used limited dependent variables in the manner presented in this chapter. In the end of the 1980's publications by Jones (1989) and Pudney (1989) further discussed the behavioural differences of each model by focusing on how each model accounts for zero observations on the dependent variable in different ways. The eighties witnessed a proliferation of the use of these models in the spirit of Blundell and Meghir (1987) in most fields of applied micro-econometrics (e.g. Blaylock and Blisard 1992; Garcia and Labaega, 1996). Moreover, the 1990's also witnessed a plethora of publications that addressed the issues of non-normality and heteroscedasticity (e.g. Yen, 1993; Jones and Yen, 1994; Yen and Huang, 1996; Su and Yen, 1996; Jensen and Yen, 1996; Yen *et al.*, 1996, Yen and Jones, 1997). LDV models have also infiltrated the analysis of CV data (see next footnote).

[2] Recent examples of the use of limited dependent variables models for the analysis of CV data include Maguire *et al.* (forthcoming 2003), Mourato, Kontoleon and Danchev (2002), Dalmau-Matarradona (2001), Lusk *et al.* (2001), Brown and Taylor (2000), Kenyon and Hanley (2000), Clinch and Murphy (2001), Yoo *et al.* (2000), Johnson *et al.* (2000) Johansson (1999), Mourato and Pearce (1999), Alvarez-Farizo *et al.*, (1999), Donaldson *et al.* (1998), Roosen *et al* (1998), Romer *et al.* (1998) Berrens *et al.* (1998), English (1997), Kwak *et al.* (1997), Donaldson *et al.* (1997), Cooper and Keim, (1996), Roe *et al.* (1996), Howe, *et al.* (1994), Bockstael *et al.* (1991), Hanley and Craig (1991) and Halstead *et al.* (1991). Application of LDV models date back to the 1980's (e.g. Edwards and Anderson 1987). Finally, note that the model of Cameron and James (1987) - often cited as the

First, many CV practitioners have relied on follow up questions to accomplish a classification of zero WTP responses (mainly into abstentions and corner solutions) that will assist model selection. Yet, this approach is often arbitrary since it relies on the subjective interpretation of what the responses to follow-up questions mean. This may lead to erroneous interpretation and classification of zeros and subsequently incorrect econometric model selection. [3] This chapter presents a less restrictive modelling approach that allows the data itself to dictate which is the most appropriate limited dependent variable model when accurate identification and classification of zero responses is difficult.

Second, even if classification of zero responses into abstentions and corner solutions is possible *via* the information obtained from the responses to follow up questions, there will always be a residual category of zero responses that will be very difficult to classify. These are 'protest' bids, which are commonly taken to correspond to people who 'are in the market' but for one reason or another report a zero bid. Once identified these observations are usually dropped from the sample as being somehow 'invalid'. Yet, this approach unnecessarily excludes information and may lead to forms of sample selection bias. The current chapter shows how protest zeros can be treated econometrically and may contribute both to the estimation of the parameters affecting WTP but also to the calculation of expected WTP. Models where protests can and cannot be identified will be presented and the relative merits of each will be discussed.

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appropriate modelling approach for dealing with payment card data - is nothing but a limited dependent variable model (akin to the Tobit model) with multiple censoring points.

[3] The poor quality of the information obtained from follow up questions can be attributed to various factors. In cases of open ended follow up questions the interviewer has to interpret and in some cases code the responses 'on the spot'. In mail surveys, the processes of inputting the data into the computer also involves subjective interpretation. Further, pre-coded follow up questions may not cover all the reasons for reporting a zero WTP value. Including too many pre-coded alternatives may cause confusion to respondents. Including too few may cause confusion to the analysis since the responses will be of greater generality. Also, a 'other' option is included in the list of pre-coded responses. Again subjective interpretation of these responses is required. Finally some researchers neglect to obtain follow up information (e.g. Calia and Strazzera 2000) although including follow up questions has become the norm in CV practise. A more promising approach is perhaps to identify the sources of protest and then see if protest responses would be eliminated if this factor were to be varied. See for example Morrison *et al.* (2000) for how varying the elicitation method allows for better identification of protests and thus better WTP estimates. Jorgensen *et al.* (1999) have shown that altering the elicitation format would still produce protestors since people are in general protesting against the principle of WTP. Yet, what is flawed about such work is that it assumes that protests are cuased by a single factor (say the elicitation method). Yet, protesting could be the result of many reasons and could equally reflect misreported values or corner solutions. Hence improving design aspects may reduce the number of some types of protestors but may not affect the number of others (see Soderqvist ,1998).

Third, many applications of LDV models for the analysis of CV data have imposed arbitrary and unnecessary restrictions on the models themselves. For example, many studies have used the simple univariate Tobit model excluding the possibility of any abstentions. Other studies have used 'dominance' models (such as the Heckman selection model) that exclude the possibility of any corner solutions (i.e. real zeros). Moreover, other applications have used bivariate Tobit or double hurdle specifications to model the decision to report a zero or non-zero WTP value ('participation') and the decision over how much one would be willing to pay once in the market ('payment'). These studies have invariably assumed independence between the participation and payment decisions.[4] Yet, such a restriction is an empirical issue and should not be imposed *a priori*. Forcing independence on the hurdle model will lead to inconsistent parameter results (Blundell and Meghir, 1987). The current chapter shows the consequences of this restriction and for the first time displays estimated hurdle models that relax the independence restriction.

Fourth, many CV studies motivate the use of LDV models on statistical rather than behavioural grounds (e.g. Clinch and Murphy, 2001). This lack of positing an explicit behavioural model underlying the econometric structure has often lead to *ad hoc* parameter specifications since there is little guidance as to what variables affect the various decisions that lead to WTP responses (e.g. the participation or payment decision). For example, what is the nature of the participation decision? How does it differ from the WTP decision? Which variables and in what way should affect each decision? Such questions have received little systematic attention in CV data analysis. The current paper shows that the family of LDV models can be based on a behavioural model of discrete random preference regimes (Pudney 1989). This conceptual framework accounts for preference heterogeneity between non-demanders and demanders (current and potential) and allows for the formation of testable hypothesis as to the determinants of the participation and payment decision.[5] Moreover, the

[4] For example, Maguire *et al.* (forthcoming 2003), Lusk *et al.*, (2001), Brown and Taylor (2000), Mourato and Pearce (1999) and Johansson (1999) use Cragg's double hurdle model to analyse OE WTP CV data. Yet, the Cragg model is a restrictive Tobit model in that it imposes independence between the error terms of the participation and payment decision. This assumption has not been examined in any of these applications.

[5] It should be noted that many applications of LDV models for the analysis of demand for *private* (market) goods also suffer from a lack of theoretical direction. In fact, many econometricians (e.g. Burton *et al* 1996) argue that economic theory provides little guidance on which variables to be included in each decision nor on what sign to expect (especially for the participation decision). Yet, the behavioural framework provided in Pudney (1989) may offer some direction.

determinants of the decision-making processes that are explored are not limited to demographic variables. In line with the increasing interest in exploring psychometric data in the analysis of choice (Ben-Akiva *et al.,* 1997) we investigate in what manner attitudinal and motivational variables affect the different types of decisions governing the data generating process (i.e. the participation and/or payment decision).

Fifth, the validity of econometric mixture models of discrete and continuous decisions heavily rests on assumptions of normality and homoskedasticity of the error terms associated with these two decisions (Green, 1997). Yet, CV practitioners that have used these models neglect to perform diagnostic tests to examine the validity of these assumptions and have consequently failed to employ appropriate corrective measures when they are violated. The application presented in this chapter utilises two alternative transformations of the continuous dependent variable (the Inverse Hyperbolic Sine and the Box-Cox transformation) to account for violations of the normality assumptions. Moreover, a parameterisation of the variance of the payment decision is employed to cater for violations of homoskedasticity.[6]

The generalised limited dependent variable modelling approach is explored in a data set of payment card WTP responses for a programme for the conservation of the Giant Panda. The results show that allowing the data to suggest the appropriate model significantly alters the results of the analysis. Further, it is shown that the restriction of independence is not always warranted and thus must not be routinely used. In addition it is shown how sample separation models can be utilised to provide more clear information as to the factors affecting abstentions, corner solutions and misreported zeros. Finally, the paper reveals how to account

[6] Kwak *et al* (1997) apply the symmetrically trimmed least squares estimator (STLS) on a data set of censored OE WTP data from a CV study on drinking water quality in Seoul. The STLS is a semi-parametric estimator proposed by Powell (1988) that accounts for heteroskedastic error terms frequently found in censored data It has, thus, been suggested as an alternative to the Tobit model when heteroskedasticity and non-normality is suspected. The estimators from the STLS model are consistent and asymptotically normal. Results from STLS have been shown to be quite robust to unknown heteroskedasticity. Also, the model has the attractive feature of avoiding the difficult task of correctly specifying the parameters of the variance. A similar approach is the least absolute deviation (LAD) Tobit estimator. See Yoo *et al.* (2000) for an application to CV data. However, the STLS and LAD approaches have been criticised for imposing restrictions on the behavioural/cognitive processes generating the data. Namely the models assume that participation and payment are specified by the same underlying parameters and that all zeros are expressions of corner solutions. The bivariate Tobit models avoid imposing such behavioural restrictions. Moreover, Clinch and Murphy (2001) in their use of double hurdle models attempt to account for asymmetries in the WTP distribution by utilising the Weibul distribution. Yet, the authors acknowledge that it is preferable to use more general and flexible distributions that nest the normal distribution as a special case. This is exactly the approach taken on the current paper.

for non-normality distributed and heteroscedastic error terms when analysing OE-type WTP data.

Before proceeding a few caveats are in order. First, the points made in this chapter equally apply to all elicitation formats that directly try to elicit the individuals 'reservation price'. These include purely open-ended WTP questions, payment card and ladder methods (including random card sorting methods) as well as certain auction and bidding elicitation methods used in some CV studies undertaken in laboratory settings. Discrete choice or referendum elicitation formats involve a different cognitive task whereby individuals reveal whether their reservation price is lower or higher than the offered bid. WTP is then indirectly inferred econometrically (Cameron *et al.,* 2002). The appropriate treatment of 'zeros' or 'nay saying' in referendum contingent valuation data poses various modelling challenges that will not be addressed here.[7] Secondly, the chapter does not engage in the debate over whether OE elicitation formats *should* be used or not. Bateman *et al.* (2002), Cameron *et al.* (2002), Reaves *et al.* (1999), Ready *et al.* (1996), Brown *et al.,* (1996), Loomis (1990) provide an overview of this literature and the issues involved.[8] For some CV analysts the debate has been resolved in favour of discrete choice elicitation formats (e.g. Carson, Groves, and Machina, 1999) while for others the debate is as open as ever (e.g. Harrison, 2001, Reaves *et al.* 1999; Green *et al.,* 1998, Rowe *et al.*, 1992). For the purposes of this chapter, what is important is that OE-type elicitation formats *are* still widely used and preferred by many practitioners.[9] Lastly, the chapter is pre-occupied with *parametric* models for analysing censored WTP distributions. Admittedly, parametric estimation of the moments of the WTP distribution such

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[7] Although some of the issues discussed in the chapter are also relevant for the analysis of referendum data. For example, in both cases the main problem with treating 'zero' responses has to do with the difficulty in identifying and interpreting the nature of these responses. Also, in both cases this identification is essential for deciding the appropriate econometric specification for estimating the desired welfare measure. Recent papers by Bohara *et al.* (2001), Hanemann and Kanninen (2000), Curtis (2000), Calia and Strazzera (2000), Strazzera *et al.* (2000), Huhtala (2000), Wang (1997), Werner (1999), Haener and Adamowicz (1998), Kristrom (1997), Hanemann and Kristrom (1995) have presented various mixture models that attempt to address the problems created by zero responses to referendum type WTP questions. For example, Curtis (2000) offers similar arguments as the ones presented in this chapter in his attempt to model people who are out of the market, corner solutions (either real zeros or protests) and positive WTP values. In addition, the contribution of Kristrom's spike model to the analysis of DC data is that it allowed for some of the zeros to be abstentions whereas previous DC analysis assumed that all zero WTP bids were corner solutions. Kristrom also modelled protest (interpretd as strategic bidders) as corner solutions (see Kristrom, 1997).

[8] Some of main findings from this literature are that WTP estimates from OE data tend to be lower than DC data (partly on account of protests in responding to the former and yea saying in responding to the latter) and that WTP estimates from the two elicitation formats differ in their levels of hypothetical error and temporal stability.

[9] See the latest assessment of the CV method by a panel of leading CV experts (Bateman *et al.*, 2002).

as E(WTP) is becoming increasingly obsolete in the face of new non-parametric estimating techniques.[10] Yet, Alvarez-Farizo *et al.*(1999) point out that the choice of appropriate parametric model (or bid function) is still very relevant for three reasons. First, to examine the behavioural underpinnings of the data generating processes and to acquire valuable insights to key policy variables (such as income elasticity of WTP). Observing whether such variables are in accordance with prior exceptions or with economic theory provides a form of theoretical or construct validity (Arrow *et al.*, 1993). Hence, obtaining estimates from appropriate parametric models is still highly pertinent for policy purposes even if they are not strictly used for estimating E(WTP).[11] Secondly, to explore "discriminant validity" or whether the bids can satisfactorily be explained by the variation in other covariates (e.g. demographics). This would be determined by goodness-of-fit measures.[12] Third, parametric bid functions can be used in benefit transfer exercises (e.g. Bergland *et al.*, 1995). The enhanced significance of the policy role of benefit transfer under the new EU Environmental Liability directive increases the need to obtain better parametric (and not simply welfare) estimates (see last chapter). Also, Bateman *et al.*, (2002) show how determining the appropriate parametric model of WTP may prove useful in deciding the "best fit" *non*-parametric estimate of mean WTP.

4.3. Types of zero WTP responses

Many CV studies using an OE-type elicitation format report a large proportion of zero WTP responses. These responses are due to various reasons. Some may represent individuals who are out of the market or abstain from the contingent market. Put differently, the good in question is not in the individual's preference set. Other zeros may be expressions of corner

[10] Parametric estimates of mean WTP have been found to be heavily dependent on the distributional assumptions made for the latent random variable y representing notional WTP (e.g. normal, log-normal, exponential, Weibull, Gamma and Beta families of distributions). Use of non-parametric models avoids the reliance on stringent distributional assumptions. Non-parametric estimators commonly used for the analysis of various types of WTP date are discussed in Bateman *et al.* (2002).

[11] A considerably large sample size would be required to estimate some sort of semi-parametric regression in order to explore behavioural implications. Even in such a case the parameters would only be identified up to scale (Clinch and Murphy, 2001, p. 430).

[12] For example Mitchell and Carson (1989) set a R^2 threshold level of 15%. Such R^2 measures should be considered with care since when using non-linear WTP models. Instead other measures based on the log-likelihood statistic are more informative.

solutions whereby the individual is in the market but their WTP is nevertheless driven to zero.[13] Throughout this chapter we follow the more general micro-econometric interpretation of abstentions and corner solutions according to which the former are the result of variables affecting the participation decision while the latter are caused by variables affecting the payment decision (e.g. Blundell and Meghir, 1987; Garcia and Labeaga, 1996; Bockstael *et al.*, 1991; Deaton and Irish, 1984; Jones and Yen, 1996).

If the researcher could determine the precise reasons generating zero bids (e.g. abstention or corner solutions) then it would be much more easy to choose the appropriate econometric specification. Yet, even if we are able to identify and classify abstentions and corner solutions, the problem of model selection still persist since there will always be a residual category of zeros that cannot be easily classified into one of these two categories, namely protest zeros.[14] Protest responses are a persistent problem in many CV data sets (see Jorgensen *et al.,* 2000; Lindsey, 1994). Richard Carson (2000) defines protest responses as occurring when a respondent

> "... gives a response of $0 to a question which requests an actual WTP response even though the respondent has a positive WTP for the good".

In econometric terms protest responses can be viewed as a problem of misclassification and misreporting. An individual that provided a zero WTP response may in fact be a true corner solution but the analyst may be unable to classify the respondent as such. This would be a case of misclassification. Alternatively, a respondent may have a positive latent WTP for the good in question but for some reason or another reported a zero value. This would be an instance of misreporting which in most cases takes the form of under-reporting.[15] This

[13] For a discussion of modelling corner solutions see Pudney (1989).
[14] Other types of zero responses are "don't knows" and incomplete responses (e.g. refusals). For an analysis of such data see Haener and Adamowicz (1998). In this study we did not have any WTP non-response since the interviews were conducted face-to-face. Only three respondents stated that they did not know why they gave a zero WTP. These were treated as protest zeros in line with Alvarez-Farizo *et al.* (1999).
[15] In the latest assessment of CV commissioned by the UK's DETR, the report states that: "It has been suggested by the critics of CV that these households are unwilling to place a value on the provision of a non-market good because they find it impossible to express their value for such a good in monetary terms. The implication has been that the zero responses of these households actually reflect extremely high values. Amongst CV researchers, the general feeling is that very few zero responses are protests reflecting very high value. Instead it is more likely that they represent the free-riding behaviour of households with low WTP." (Bateman *et al.*, 2002)

phenomenon has been attributed to strategic responses that intend to reduce the level of payment that will be exacted if the good is actually provided. Alternatively the individual may not be thinking in terms of providing maximum willingness to pay but rather may be internally comparing the perceived cost of the project to his/her latent reservation WTP. If the former is believed to be higher than the latter, then under an OE-type elicitation format a zero WTP is (erroneously) reported (Carson *et al.,* 1999; Bohara *et al.,* 1998).

The rationale of interpreting protest responses as misclassified and/or misreported values is the same as that used to interpret misreported expenditure figures in household micro-data sets. Although expenditure for consumer goods that are essential or are defined very broadly (e.g. clothes) is almost always positive, for some reason or another a high proportion of zero purchasing levels for such goods is often reported. Since the aim of the analysis is latent expenditure and not actual purchase, econometric models have been developed to account for misclassified and misreported expenditure values. The current chapter extends these models developed from the household expenditure literature to the analysis of protest responses in CV data. The analogy exploited is between latent expenditure and latent WTP as well as between reported purchase and reported WTP. The reasons for misreporting may differ across the two sets of applications. Yet, the rationale for using the models described below is common in both cases.

Though some researchers choose to include protest responses as real zero bids (corner solutions), most exclude them from the analysis (Jorgensen and Syme, 2000). This has raised numerous objections from several authors (e.g. Spash, 2002 and 2000; Rekola *et al.*, 2000) who reasonably argue that excluding such responses is an arbitrary practice that undermines the validity of the CV method itself. The current chapter explicitly acknowledges that zero observations, including protest zeros, contain valuable and diverse information. This source of rich information should be included in the analysis of the data but should be done so in the most flexible manner so that the data itself suggests the most appropriate econometric model to be used.

4.4. Modelling abstentions as discrete random preference regimes.

Stylised economic theory holds that a set of goods are permanently 'inbred' into one's utility or preference function. Under such a view a zero WTP response to an OE-type elicitation question is considered to be a corner solution. That is, under current prices and income the individual refuses to pay any amount implying that ones reservation price is driven to zero. Yet, there is accumulating evidence from micro-data of both revealed and stated preferences that suggests that not all individuals have the same preference structures nor are all goods ingrained in each individual's utility function. For example, there are certain goods that some individuals would not want to have even if they were free goods (Freeman, 1993). A fruitful way of conceptualising such differences in preferences is provided by Pudney (1989) and Blundell and Meghir (1987) who postulate a model of discrete random preference regimes. This model provides a plausible behavioural framework on which to base the statistical models developed in the next section. Note that most researchers have motivated the use of LDV models in the context of analysing OE CV data on statistical grounds (e.g. Clinch and Murhpey, 2001; Dalmau-Matarradona, 2001).[16] The problem with a statistical motivation is that the practitioner is left with no guidance as to what variables should be included in the various decisions that lead to the observance of a WTP bid.

For the case of market goods, such as cigarettes, the discrete random preference regime model assumes that current and potential smokers have different preference structures than non-smokers. The model assumes that no non-smoker would not want to consume cigarettes - at any prices or income levels - so the demand curve should be estimated only over current and potential market participants (Pudney, 1989; Blundell and Meghir, 1987). This framework is helpful in understating zero responses to OE WTP questions . A zero WTP could be the result of two different types of preference structures. For example, those who do not care about a particular public good would not be willing to support its provision whatever their personal income level or the relative prices they face .[17] Following this reasoning, we can model zero WTP for non-market goods by means of a discrete shifter variable altering the nature of

[16] An exception is Johansson who has used the discrete/continuous mixture models presented by Dubin and McFadden 1984) as the basis for using dominance models to analyse hypothetical WTP for charity donations.
[17] Curtis (2000) also uses the framework described here to analyse 'nay saying' in DC CV data.

individual preference. To fix ideas consider the demand for a public good such as the conservation of a particular species (say the Giant Panda). Let, the utility function of the individual be

$$U = u(c, q) \qquad \text{Eq. 1}$$

where c is the composite good representing all market goods and q are levels of quality/quantity of panda conservation. We can model the distinction between those who would never support panda conservation under any circumstances and those for whom WTP is an economic decision (based on relative prices, income and other quality variables affecting the level of WTP) by means of an observable discrete binary variable I. This variable can be assumed to be generated by a latent variable $I^* = I\ (a'Z)$ where Z is a vector of variables determining I^* and α' the corresponding parameter vector. The binary observable outcome is such that:

I = 1 if $I^* > 0$ and
I = 0 if otherwise

Utilising this variable, consider the preference relation:

$$u = I \cdot U(c, q; X) + (1 - I) \cdot U^*(c; X) \qquad \text{Eq. 2}$$

where X contains all *other* variables besides those in Z and $U(\bullet)$ and $U^*(\bullet)$ are the utility functions representing the preference of demanders (actual and potential) and non-demanders of this public good. For non-demanders $(I^* = 0)$, q does not affect preferences, and subsequently WTP for q will be zero in Eq. 2. For actual and potential demanders of q $(I = 1)$ the solution to the utility maximisation problem:

$$\max_{c} \ u = U(c, q; X) \qquad \text{Eq. 3}$$
$$st \quad \sum_{i} p_i \cdot c_i \leq m$$

will yield an indirect utility function (*v(p,q,m)*) that can be used to construct the income compensating function with the general form (see Willing 1976, Whitehead 1998, McConnell 1990 for details): [18]

$$y^* = f(p, q_i, z, m, X) \qquad \text{Eq. 4}$$

where y^* is latent WTP, p the price of all market goods, q_i the levels of quality/quantity of the specific public good we are examining, z are all other public goods, m individual income, and X individual tastes and characteristics. Each individual's maximum WTP for a change in the quantity/quality of a particular public good from q_o to q_1 is the amount required to place him/her on their initial utility levels. A corner solution would emerge in the case where the good in question enters ones preference set but for some factor in $f()$, y^* is driven to zero. This could be some factor associated with the respondent (e.g. income level) but also with the good in question (i.e. q_i). For example, according to Carson *et al.* (1999) when the perceived costs of the project are higher than notional WTP the incentive compatible response to an OE-type WTP question would be zero. Following this reasoning, individuals who are in the market but record a zero WTP due to some factor in their WTP function can be seen as real corner solutions or may simply be concealing a positive WTP value (protests).

This general framework provides the behavioural basis for the models described below. Non-demanders are best viewed as having a different preference function than actual or potential demanders. Abstentions are thus described as a separate non-economic decision that may be better explained by taste and attitudinal variables.[19] Real zeros and protests (defined as misclassified real zeros or misreported positive values) are explained by covariates in ones WTP or payment decision. The latter may include both attitudinal and demographic characteristics. This framework allows the researcher to incorporate all zero responses in the analysis without imposing a priori restrictions as to the nature of these zeros.

---

[18] Note that in most CV applications q and p does not vary and thus will drop out in the specification of the estimated model. They are in essence kept constant and their effect on WTP is captured by the constant term (see Kwak *et al* 1997, Yoo *et a*l 2000).

[19] Yet, certain demographics (such as ones location of residence) may explain abstention over certain public goods.

4.5. Generalised Limited Dependent Approach to Modelling CV data.

The behavioural framework discussed above is translated to a general statistical model that can accommodate all the types of zeros discussed in Section 4.3. The econometric specification is generated by assuming a binary process for the realisation of I^* (such as a binary Probit model) and some functional form generating the income compensating function (or WTP function) for those individuals with $I^*>0$. When such a function is generated through an OE-type elicitation format, the WTP function can be modelled as a censored distribution (Cameron and James, 1987, Whitehead 1998). The resulting statistical structure is a mixture model of a discrete and censored distribution (Pudney 1989).

In the subsections below we describe a series of mixture models that consider the individual WTP decision as a composite cognitive process. The variants of the models that are considered are determined by the assumptions made about the relationship between the error terms between the component decisions and on the assumptions made about the concept of 'dominance'. The latter refers to whether the participation decision dominates the payment decision such that if a one participates it is certain that a positive WTP will be observed.[20] Selectivity models (e.g. Heckman 1979) are examples of specifications that assume dominance while bivariate Tobit models (e.g. Cragg 1971) are examples of models that do not evoke the dominance assumption.

For the analysis of CV data we can consider two sets of models. The first, assumes that types of zeros cannot be satisfactorily identified. These lead to a series of bivariate Tobit and dominance models without sample separation. If identification of types zeros into abstentions, corner solutions and protests is possible then we can introduce a third equation, 'reporting', that records whether one has reported a positive WTP given they are in the market (they have passed the participation hurdle). This will allow us to directly account for protest bids. This sample separation model involves a trivariate model. Both sets of models (with and without sample separation) are described in the two sections below.

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[20] The concept of dominance was introduced by (Jones 1989).

The motivation for using this generalised limited dependent variable model is the same as that found in many analyses of Engle-curve and expenditure functions: the analyst is uncertain in identifying and classifying qualitatively different zero observations. [21] By 'generalised' it is meant that (a) all observations and types of zeros are retained in the analysis. No responses (either zero or non zero) are arbitrarily excluded nor are presumptions made regarding the nature of zero responses; (b) no *a priori* restrictions are imposed on the relationship *between* the participation and payment decisions; (c) the *data itself* is allowed to suggest which is the appropriate model to use; and (d) cases where crucial distributional assumptions (such as normality and homoscedasticity) are violated are accounted for.

4.5.1 Sample separation not possible: bivariate models.

Assume latent WTP for an individual i is a continuous variable y_i^* characterised by the following simple linear function:

$$y_i^* = \beta' X_i + \varepsilon_i \qquad \text{Eq. 5}$$

In principle $y_i^* \in (-\infty, +\infty)$. The vector X includes the variables that determine the latent continuous variable and ε is an error term (for now assumed to be *iid*). If all observed zeros were 'true' zeroes (i.e. $y_i^* = 0$), then OLS would be the appropriate specification to estimate a conditional WTP model. Yet, if observed zeros on the dependent variable are indicators of censored or incorrectly observed or coded values, then OLS will yield biased and inconsistent results (Green, 1997). In this case limited dependent variable and selectivity models have to be utilised (Blundell and Meghir, 1987). To frame such models an additional relationship is introduced:

$$I_i^* = \alpha' Z_i + v_i \qquad \text{Eq. 6}$$

[21] Jones and Posnett (1991), appealing to the-reduced form argument of Hausman, suggest that the double hurlde model can be viewed as the reduced form of a structural model that augments the demand equation with separate hurdles for different non-behavioural sources of zeros.

where I^* has the same meaning introduced in Section 4.4, that is it represents a latent variable that determines *participation* in the market. The vector Z includes variables that determine and v_i an *iid* error term. An individual does not abstain or participates in the market if $I^*>0$. In practice I^* is not observed but we observe the binary variable I which takes the value '0' if the individual gave a zero response and '1' otherwise. In principle the variables in the vectors of socio-economics explanatory variables, X and Z) can overlap. A zero observation attributed to a corner solution occurs when the individual has $I^*>0$ but for certain levels of the variables in X *ones* value (i.e. y^*) drops to zero. Corner solutions also include censoring where $y^*<0$ (disutility). Individuals that pass the first hurdle are considered to be actual (when $y^*>0$) and potential demanders (when $y^* \leq 0$) of the good (Garcia and Labeaga, 1996; Deaton and Irish, 1984; Jones 1992).

Using Eq. 5 and Eq. 6 we can construct a very general model where both positive and zero observations are retained such that:

$$
\begin{array}{lll}
y_i = y_i^* & \underline{if} & y_i^* > 0 \ \underline{and} \ I_i^* > 0 \\
y_i = 0 & otherwise &
\end{array}
\qquad \text{Eq. 7}
$$

This model can be used to construct a generic likelihood function that will have the following general form:

$$
L = \prod_0 \underbrace{1 - \Phi(+)}_{(a)} \cdot \prod_+ \underbrace{f(y > 0 / \bullet)}_{(b)} \cdot \prod_+ \underbrace{\Phi[+]}_{(c)} \qquad \text{Eq. 8}
$$

Section (c) of Eq. 8 is a cumulative density function (CDF) that gives the probability that a positive value of y is observed. Distributional assumptions regarding Φ have to be made. Section (b) is a conditional probability density function (PDF) for the positive observations (or the expectation that $y>0$). As will be shown bellow the nature of this conditional PDF determines the type of model that emerges from this general specification. Segment (a) is the CDF that gives the probability of observing a zero response. Note that the products over (c) and (b) are taken over the range of possible positive observations while that over segment (a) is taken over zero observations.

Using the general specification of Eq. 7 and the generic likelihood of Eq. 8 we can construct the range of bivariate and univariate Tobit models as well as dominance models that are suitable for analysing data generated from such a discrete/continuous choice model. The variations in the models depend on the assumptions made for the error terms between these two decisions and on the concept of dominance. The former refers to whether the two decisions are dependent or independent (i.e. whether $\rho_{\varepsilon,v} = 0$) while the latter refers to whether the participation decision dominates the payment decision.

Bivariate Tobit Models (Blundell and Meghir, 1987), also know as double hurdle models (Cragg, 1971) assume that the individual must overcome two hurdles before a positive value for y^* is observed. The individual must be "in the market" or must not abstain (which is given if $I^*>0$), but also the individual must *not* be a corner solution (which is given by $y^*>0$). If any of these two hurdles is not overcome then the individual is coded as having a zero value for y^*. In its most general form the double hurdle model assumes that the errors between the participation and payment decisions are dependent and follow a bivariate normal distribution:

$$(\varepsilon, v) \sim BVN(0, \Omega), \text{ where } \Omega = \begin{bmatrix} \sigma_\epsilon & \sigma_\epsilon \cdot \rho \\ \sigma_\varepsilon \cdot \rho & 1 \end{bmatrix} \qquad \text{Eq. 9}$$

Under these general assumptions we can construct what is known as the 'double hurdle dependent' model (DHD) (Garcia and Labaega, 1996; Blundell and Meghir, 1987, Jones, 1992) with likelihood:[22]

$$\begin{aligned} L_{DHD} = &\prod_0 [1 - P(v_i > -\alpha' Z_i) \cdot P(\varepsilon_i > -\beta' X_i / v_i > -\alpha' Z_i)] \times \\ &\prod_1 P(v_i > -\alpha' Z_i) \cdot P(\varepsilon_i > -\beta' X_i / v_i > -\alpha' Z_i) \cdot f(y_i / \varepsilon_i > -\beta' X_i, v_i > -\alpha' Z_i) \end{aligned} \qquad \text{Eq. 10}$$

A more detailed derivation of these models is provided in Appendix 2. The expression for the DHD involves the density and distribution functions of the *truncated bivariate normal* distribution (see Jones, 1989). Maximisation of Eq. 10 requires the evaluation of a bivariate normal distribution and the results yield consistent estimates of the parameter vectors α' and β' as well as the additional parameters ρ and σ. The double hurdle model in its most general form of Eq. 10 has not been widely utilised in the revealed preference demand literature while it has never been employed in the analysis of stated preference data. This may partly be explained by the slight complexity involved in maximising Eq. 10. Yet, most up to date econometric software packages can now evaluate bivariate distributions and thus it is not prohibitively difficult to programme such likelihood functions. Past applications of the DHD model have been programmed in FORTRAN (e.g. Yen 1993) or Gauss (e.g. Blundell and Meghir, 1987; Garcia and Labeaga, 1996) , Jones and Yen (1994). The current application programmed and maximised all likelihood functions using Intercooled STATA - Version 6. The programme codes and optimisation process is provided in Appendix 3.

By imposing restrictions on the general model of Eq. 10 we can obtain an array of more specific models. If we assume that that the error terms in Eq. 5 and Eq. 6 are independent (i.e. $\rho = 0$) then we obtain the double hurdle *independent* model (DHI) with likelihood:

$$L_{DHI} = \prod_1 P(v_i > -\alpha' Z_i) \cdot P(\varepsilon_i > -\beta' X_i) \cdot f(y_i / \varepsilon_i > -\beta' X_i) \cdot \prod_0 [1 - P(v_i > -\alpha' Z_i) \cdot P(\varepsilon_i > -\beta' X_i)] \qquad \text{Eq. 11}$$

Maximisation of Eq. 11 yields consistent estimates and is based on evaluating two uni-dimensional random variables (ε_i and v_i) as opposed to the DHD model that is based on the evaluation of a bivariate truncated distribution. The DHI model was first introduced by Cragg (1971) and has been widely used in a huge amount of empirical studies including the analysis of CV data sets. Yet, it will be shown in the following sections that the imposition of the assumption of independence may lead to model misspecification and is not warranted in all cases.[23] It is worth noting that the 'spike' model used by many CV analysts (Kriström, 1997; Hanemann and Kriström, 1995) is a special case of a hurdle model. The spike model treats the

---

[22] The mixture model described in Curtis (2000) for referendum CV data is complementary to the double hurdle models (with censoring) in that they both allow respondents that have stated a zero WTP to be classified as 'in the market', 'out of the market' or 'opposed to the market'.

[23] One of the reasons behind the popularity of the DHI (even in the analysis of CV data) lies in its great ease in estimation. Some software packages (e.g. LIMDEP) contain preset commands for running the model. Moreover, even if we do not use the full information maximum likelihood estimator one can use a Probit model on the entire sample for the participation decision and then a truncated regression on the positive observations for the WTP decision and still obtain consistent results.

probability of zero bids as an unknown constant while the hurdle model parameterise this probability (Clinch and Murphy 2001). Apart from this difference the likelihood functions of the DHI and spike models are equivalent.

If we impose the additional restriction that $P(v_i > -\alpha' Z_i) = \Phi(\alpha' Z) = 1$ (which implies that $\Phi(-\alpha' Z) = 0$) we derive the standard Tobit model for censored data that assumes that the first hurdle is irrelevant (Amemiya, 1984; Tobin, 1958). The likelihood function is given by:

$$L_{Tobit} = \prod_1 P(\varepsilon_i > -\beta' X_i) \cdot f(y_i / \varepsilon_i > -\beta' X_i) \cdot \prod_0 [1 - P(\varepsilon_i > -\beta' X_i)] \qquad \text{Eq. 12}$$

Under the Tobit the same factors determine *both* the participation and payment decision. Because of this restriction all zero observations under the Tobit model correspond corner solutions (Garcia and Labaega, 1996). Also, the Tobit model assumes that all individual have the good in question in their utility function.

The univariate models (Tobit) only allow a differentiation between zero (limit) and positive (non-limit) observations whereas bivariate models (hurdle models) allow for differentiation among the *reasons* generating the former. Hence, hurdle models are relevant when we wish to say something more about the nature of zeros. If an individual has no demand for the public good (true abstention) then all variables in X_i are irrelevant. According to the Section 4.4 such responses would be most likely determined by qualitative variables in Z_i. Yet CV participants usually include both current and potential demanders of the good. The latter refer to individuals who may potentially demand the public good *but for certain levels of the variables in X_i or for some unobserved reason captured in the error term ε* may decide not to consume it. This would give rise to a zero akin to a corner solution (Garcia and Labaega, 1996). Hence, whereas abstentions are seen as the result of a separate discrete choice, corner solutions are the results of marginal adjustments. It is an empirical issue whether such an interpretation holds for CV WTP data. In essence the hurdle models deal with the problem of misclassification and can be viewed as Tobit models with random misclassification (Meghir, 2000). The model acknowledges that qualitatively different types of zeros are present but does not explicitly identify the (groups of) individuals that correspond to each type of zero response. Such misclassification or 'contamination' has to be dealt with statistically (Deaton and Irish, 1984).

A different statistical structure to the generic model described in Eq. 7 and Eq. 8 is provided by the so-called 'dominance' models. Under the dominance assumption, once the decision to participation is made (i.e. $I_i^* > 0$) the individual will have a positive WTP (i.e. $y_i^* > 0$). Hence, dominance implies that no individual can be observed at a standard corner solution (Bockstael *et al.* 1991; Blaylock and Blisard, 1992). More, formally, the statistical restriction of dominance is $P(y^* < 0 / I^* = 1) = 0$. Note, that dominance models are not nested in the general hurdle model of Eq. 10 but consist of a different statistical structure (see Blundell and Meghir, 1987).

If we retain the assumption that the errors of the participation and payment decisions are not independent but follow a bivariate normal distribution we obtain the likelihood:

$$
\begin{aligned}
L_{FHD} = & \prod_1 P(v_i > -\alpha' Z_i) \cdot f(y_i / v_i > -\alpha' Z_i) \cdot \\
& \prod_0 [1 - P(v_i > -\alpha' Z_i)]
\end{aligned}
\qquad \text{Eq. 13}
$$

This has been referred to as the 'first hurdle dominance' model (FHD) (e.g. Garcia and Labeaga, 1996) which can be shown to correspond to the Type 2 model in Amemiya's seminal classification (Amemiya, 1984) or to Heckman's generalised sample selectivity full information maximum likelihood estimator (Heckman, 1979). By restricting the error terms of the two decisions to be independent (i.e. $\rho_{\varepsilon_i, v_i} = 0$) we obtain the complete dominance model (CD) with likelihood:

$$
\begin{aligned}
L_{CD} = & \prod_1 P(v_i > -\alpha' Z_i) \cdot f(y_i) \cdot \\
& \prod_0 [1 - P(v_i > -\alpha' Z_i)]
\end{aligned}
\qquad \text{Eq. 14}
$$

It can be readily shown that Eq. 14 is a two-part model consisting of two separate likelihood functions. The first corresponds to the basic Probit model (for the participation decision evaluated over all observations) and the second to the standard regression model (for the payment decision evaluated over the positive observations).

To sum up, the models described above can model zero observations as abstentions (when $I^*<0$) or corner solutions ($I^*>0$ but $y^*<0$). Protest zeros are commonly accepted to originate from individuals who are in the market but report a zero WTP (see Carson 2000, Jorgensen and Syme, 2000). Hence, protest zeros can be interpreted as forms of corner solutions (Johansson, 1999).

Also, in the discussion so far we have assumed that the information obtained from follow up question is *not* sufficient to identify types of zeros responses. Instead the hurdle models provide a statistical 'classification' of all zero responses. That is, the models allow that there will be a percentage of zeros supplied by the probabilities estimated from the first hurdle and another percentage of potential demanders whose WTP is zero when they look at prices, income and other variables, and whose probabilities are determined in the second hurdle (Garcia and Labeaga, 1996).[24]

Moreover, the assumption of error independence in the double hurdle models implies that the probability of participation is unaffected by the condition of being a potential demander and so the conditional PDF reduces to the marginal PDF for observed WTP responses (i.e. DHD reduces to DHI - see Appendix 2). Dependence between error terms allows for the possibility that the two decisions occur simultaneously, while independence implies that that the decisions are sequential. The sequential nature of the decision making process is also present in the CD model. Yet the CD and DHI models differ with respect to how they interpret zero responses. The DHI implies that the relevant population for estimating the WTP for the provision of a public good should include both those with observed WTP and those with non-observed WTP (Blaylock and Blisard, 1992). That is, both potential and actual demanders of the public good.

This is so, because the DHI assumes a feedback effect from the amount of possible payment to the participation decision. The CD model implies that the relevant population consists only of

[24] Some CV researchers have suggested that the most sensible course of action is to disregard protest from the analysis. For example Bateman *et al.*, (2002) take such a view but caution that due care must be taken so as not to bias the sample. Such systematic bias would be the case if excluding protests were correlated with the true WTP of households. For example the results of the analysis would be systematically biased if protest zeros have a very low (or high) WTP value. The authors acknowledge that the researcher doesn't know the true WTP of such households so no clear test for this sort of bias exists. Because of this many researchers assume that the true WTP of protestors will be similar to that stated by households with comparable characteristics. Under this assumption, as long as excluding non-respondents from the data doesn't bias the representativeness of the sample it shouldn't bias the analysis of the WTP data. (Bateman *et al.*, 2002). According to this reasoning protest zeros who reflect corner solutions would be qualitatively similar to those zeros who were identified as corner solutions from the information obtained by follow-up questions. Yet, this inference has to be verified since otherwise we are risking biasing the sample.

those who are observed to demand the public good, i.e. current demanders. Moreover, unlike the DHD model, the first hurdle dominance model assumes individuals with zero consumption provide no restrictions on the form and parameters of the WTP equation as none of the zeros are generated by the WTP equation (Jones, 1989). Finally, although the dominance models allow for separate participation and WTP decisions they do not allow for a variable to have an opposite affect on the two decisions. This imposes an added behavioural restriction that should be explored empirically and not imposed *a prior* (see Garcia and Labeaga, 1996; Blaylock and Blisard, 1992; Jones 1989 for a more thorough discussion of these points).[25, 26]

4.5.2 Sample separation possible: Trivariate Models

CV questionnaires almost routinely ask people for their reasons for their WTP responses. Even if not entirely satisfactory, this information can be used to identify and classify various types of zeros. Including such auxiliary information permits the type of sample separation advocated by Blundell, Ham and Meghir (1987) and Jones (1989, p. 26). They argue that *accurate* sample separation will improve the efficiency of the estimation process. What is more sample separation models would allow for richer information to be extracted from the data in that the analyst can examine the relative importance and determinants of abstentions, corner solutions but also misreported zeros.

If we utilise the information from follow up questions and we can classify zeros into abstentions and corner solutions then it can bee shown that the double hurdle model can be reduced to the composite likelihood (Jones 1989):

$$L_{\Pr obit} = \prod_{Abs} \Phi(-\beta' X / \sigma_\varepsilon) \cdot \prod_{\sim Abs} \Phi(\beta' X / \sigma_\varepsilon)$$

$$L_{Tobit} = \prod_{+} P(\varepsilon_i > -\beta' X_i) \cdot f(y_i / \varepsilon_i > -\beta' X_i) \cdot \prod_{0} [1 - P(\varepsilon_i > -\beta' X_i)] \qquad \text{Eq. 15}$$

[25] Dominance models also suffer from problems of multicolinearity in the payment decision (see Green, 1997).
[26] Overall, treatment of zeros is not merely a selection issue but an issue of utilising information and understanding how individual respond to CV questions. Hurdle models are much less restrictive than selection models in that they allow the same variable to affect the participation and payment decision in opposing ways. Hence these models may be more suitable in extracting all forms of information contained in zero responses. (see Curtis 2000 for similar argument for DC data).

Thus, using the sample separation information the log-likelihood of the double hurdle model (Eq. 11) can be split into two models. A Probit model run on the entire sample that accounts for abstentions and non abstentions (denoted as Abs and ~Abs respectively) and then a univariate or bivariate Tobit model run on the sub-sample of potential and current demanders of the good.[27]

Yet, the model of Eq. 15 is of limited use when we observe a third type of zero response, namely protest zeros. As discussed in Section 4.3, protest zeros may be qualitatively different than other types of zeros and this information needs to be accounted for in an econometric model. Protests were discussed as comprising a residual category of zeros that are not easy to classify with certainty. If we accept that protests may be either concealed abstentions, corner solutions or misreported positive bids then we are lead back to the models *without* sample separation: the zeros cannot be classified into separate groups since the various sub-samples may overlap. Hence, sample separation is in essence not possible if we allow for protest to be concealed abstentions.

However, if we accept the commonly help conception of protest zeros - as corresponding to people in the market who nevertheless report a zero WTP - then we can expect these responses to be one of two possibilities. They can either represent individuals whose latent WTP is in fact zero (but whose response to the follow question did not allow the CV analysis to classify them with certainty) or individuals who have a positive latent WTP but for some reason or another misreported their WTP.[28]

[27] Note that without the sample separation information we were not able to decompose the DHI into the Probit and Tobit specifications. When zeros cannot be classified the hurdle specification is akin to the models of random misclassification used in the analysis of household consumption surveys (Meghir, 2000).

[28] In essence we impose the restriction that protests are not abstentions. This restriction rests on the plausibility of the commonly held conception of protest zeros (i.e. as reflecting people who are in the market but stated a zero WTP).

This type of problem has been dealt with extensively in micro-econometric analysis of household expenditure data using so called 'misreporting' models (e.g. Maki and Nishiyama, 1996). In many cases economists have observed great discrepancies between data from household expenditure surveys and aggregate estimates of total expenditure on specific products (as calculated from production, imports, exports and excise duties).[29] These discrepancies have been attributed to reasons: false reporting, under-reporting, infrequency of purchase, durability of the commodity *etc.* (see Kimhi, 1999; Su and Yen, 1996; Blisard and Blaylock, 1993; Blundell and Meghir, 1987; Deaton and Irish, 1984). Yet, all these sources of misreporting have been modelled with the same statistical formulation. In all cases, zero expenditure arises either because the individual does not purchase the good because of income, price or other constraints (corner solutions) or because for one reason or the other a zero is incorrectly reported (misreporting). Which is in fact the case is not known in advance to the analysis so this 'contamination' has to be dealt with statistically (Deaton and Irish, 1984). Hence, the problem faced by the micro-econometrician in dealing with misreported expenditure levels is not conceptually different from that faced by the CV analyst in dealing with protest responses and consequently the same econometric approach can be utilised.[30]

To account for the qualitative difference between the individual's who truly abstain, those who are corner solutions and those individuals who have a positive WTP but for some reason report a zero bid (protests) it is necessary to introduce an additional equation that accounts for 'reporting' a bid once one has passed the participation hurdle. This will lead to formation of a trivariate model.[31] Let the variable k^* represent the latent variable of whether one reports a positive WTP (given they are in the market, $I^*>0$). Then, we will have the trivariate structure:

$$\begin{aligned} I_i^* &= \alpha' Z_i + v_i \\ k_i^* &= \gamma' H_i + u_i \\ y_i^* &= \beta' X_i + \varepsilon_i \end{aligned} \qquad \text{Eq. 16}$$

[29] See Maki and Nishiyama (1996) and Deaton and Irish (1984) for examples of under-reporting in expenditure survey.
[30] In fact, reveal preference data obtained from expenditure surveys contain many of the problems that have been unjustly associated exclusively to stated preference data sets.
[31] Trivariate models are similar to the generalised model in Blundell and Meghir (1987) and Kimhi (1999) in that they allow for abstentions, corner solutions and infrequency of purchase in the same model.

Where H includes the determinants of k* and γ the corresponding parameter vector. The observed counterpart of k^* is k which takes the value 1 if one reports a positive WTP and 0 otherwise. Under the trivariate model a zero is observed when the individual is out of the market or if one reports a zero WTP having passed the participation hurdle. In the latter case, zeros can be either true corner solutions or may be under-reported positive WTP bids.[32] Thus, we account for protests in that we allow these observations to be stochastically classified as either being true zeros (corner solutions) or concealed WTP bids (misreported non-zero bids).[33]

The trivariate model implies that there will be a percentage of zeros supplied by the probabilities estimated from the first hurdle (abstentions), another percentage of potential demanders who report zero (estimated by the reporting hurdle), a percentage of people mis-reporting their true values (estimated from reporting and payment equations) and a percentage of corner solution zeros (estimated by the payment equation). In its most general form (where the errors of each decision are allowed to be correlated) the trivariate model is particularly difficult to estimate because the likelihood function involves the evaluation of a truncated trivariate normal distribution for u_i, v_i, and ε_i. Yet, Jones (1989) has shown how imposing some plausible restrictions on the structure of Eq. 16 can lead to a series of much more manageable composite models. Hence, if we assume that the participation decision is exogenous, the reporting decision is endogenous, and assuming independence for the former but dependence of the latter on the payment decision we can estimate Eq. 16 using a Probit model to account for non-demanders and demanders (potential and current) followed by a DHD model involving potential and current demanders only. The DHD of this composite model can be interpreted as a misreporting model that treats zeros as either true corner

[32] The sample separation information in CV surveys does not allow the analyst to distinguish between these types of zeros. Hence, the 'sample separation' procedure refers on distinguishing between abstentions and non-abstentions. Once the abstention hurdle has been passed the observed zeros can be either misreported zeros or true corner solutions but we cannot be certain in classifying these two types of zeros responses. We are thus lead back to a random misclassification model between misreported and corner solutions zeros.

[33] The only use of the sample separation model for accounting for zero WTP data can be found in Mourato (1999). Yet, the interpretation of the hurdles between that model and the one introduced in this chapter is fundamentally different. In the model used by Mourato (1999) the first hurdle is the 'protest' decision, the second is the 'participation' and the third is the 'payment'. Thus, the model does not conform to the general definition of protest zeros as people being in the market but reporting a zero WTP. The model developed in this chapter is much closer to the rationale behind the trivariate model developed by Jones (1989) in that the first hurdle differentiates between 'non-demanders' and 'demanders' (current and potential). The CV literature considers

solutions or misreported positive WTP bids. Following this approach the (concealed) information from protest zero bids is utilised and not arbitrarily excluded.

If we impose the same restrictions on the DHD component of the model as described in Section 4.5.1, then the composite DHD model nests the composite DHI, which in turn nests the composite Tobit model. Moreover, if we retain the assumptions of exogeneity of the participation decision and assume dominance between reporting and payment then we will have a composite model comprising of a Probit model accounting for the participation decision (evaluated on the entire sample) and a first hurdle dominance model (evaluated on the sample of potential and current demanders). Imposing the independence restriction between reporting and payment leads to the composite complete dominance models. Finally, if we relax the independence assumptions between participation and reporting and assume joint dominance over payment we can estimate a bivariate Probit sample selection model.[34]

Finally, it is worth stressing that such a sample separation trivariate model can only be used if we accept the assumption that the zeros that have been identified (based on follow up questions) as protest are *not* concealed expressions of abstention. If this assumption does not hold then the various types of zeros are indistinguishable and we must resort to the models described in Section 4.5.1.

4.6. Accounting for Non-Normal and Heteroscedastic error terms.

All the models described above rely on the assumptions of univariate or bivariate normality as well as on the assumption of homoskedastic error terms. Unlike the standard regression model the occurrence of either heteroscedasticity or non-normality leads to inconsistent maximum likelihood estimates (Reynolds and Shonkwiler, 1991). Also, failure to cater for possible violations of normality and homoskedasticity assumptions may lead to unreliable specification tests. For example, we may erroneously reject the assumptions of dependence and thus opt for a model with different behavioural implications (Gao *et al.,* 1995). The effects of non-normality may become particularly acute when dealing with a dependent variable that has a

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protestors as potential demanders and thus it is more reasonable to treat such respondents as people that have passed the first participation hurdle.

[34] For an application of the bivariate Probit model to CV data see Cooper and Keim (1996). This model does not account for the censored nature of the WTP distribution and will not be explore here.

highly skewed distribution (Yen and Jones, 1996) as is frequently the case with OE-type WTP data. The current paper employs the information matrix test (Chesher 1984) and a RESET-type test for testing joint normality and homoskedasticity in the estimated LDV models.

Maddala (1983) has shown that the treatment of heteroscedasticity in LDV models is relatively uncomplicated, requiring simply the appropriate parameterisation of the variance term. Addressing the problem of non-normality, however, is much more involved. Two alternative approaches for tackling this problem are either to specify an alternative density function or to transform the continuous dependent variable (Poirier, 1978). This paper employs the latter approach by introducing two alternative transformations of WTP - the Box-Cox and the Inverse Hyperbolic Sine transformation to account for non-normal error disturbances.[35,36] Such extensions of LDV models (i.e. with parameterised error variance coupled with transformed WTP distributions) have been used in applied work on the expenditure of various market goods (e.g. Burton *et al.*, 1996; Jensen and Yen, 1996; Gao *et al.*, 1995; Jones and Yen, 1994; Yen, 1993; Blaylock and Blisard, 1992; Reynolds and Shonkwiler, 1991;) but have never been extended to non-market goods.[37, 38]

The Box-Cox transformation of y^* relaxes the normality assumption on the conditional distribution of y_i. We can construct a model where the dependent variable is transformed as follows:

[35] The only paper that has come to our attention that attempts to account for non-normality issues while using a hurdle type model for the analysis of CV data is Clinch and Murphy (2001). The authors utilise the first of the two approaches mentioned above by assuming a Weibul instead of a normal distribution to model WTP responses. Likewise Brown and Taylor (2000) use the lognormal distribution. Another plausible distribution is the Gamma distribution (see Gurmu, 1997).

[36] These are but two possible transformations of y_i^*. See Burbidge *et al.* (1988) for a discussion of more possibilities.

[37] Transformations such as the Box-Cox transformation have been widely used in the analysis of discrete choice CV data (e.g. Priez and Jeanrenaud 1999, and Day and Mourato, 1998). Yet, such transformations have not been used to model mixture model such as the double hurdle model.

[38] Failure of CV analysts to subject Tobit and hurdle models to such diagnostic tests may be due to the difficulties in correcting these problems once they are detected (Reynolds and Shonkwiler, 1991). For example, Alvarez-Farizo (1999) use Tobit models to analyse OE WTP data. They find violations of both the normality and homoskedasticity assumptions yet no measures were taken to address this problems.

$$\left.\begin{array}{l} B(y_i^*,\lambda) = \dfrac{y_i^\lambda - 1}{\lambda} \quad \lambda \neq 0 \\ B(y_i^*,\lambda) = \log(y_i) \;\; \lambda = 0 \end{array}\right\} if\ y_i^* > -1/\lambda \quad and\ \ I^* > 0 \qquad \text{Eq. 17}$$
$$y_i = 0 \quad \text{if otherwise}$$

where λ is an additional parameter to be estimated which permits the distributional generalisation of the bivariate Tobit model. Then the Box-Cox Double Hurdle Dependent (BCDHD) will have the likelihood:

$$\begin{aligned} L_{BCDHD} &= \prod_0 [1 - P(\varepsilon_i > -\beta' X_i - 1/\lambda, v_i > -\alpha' Z)] \\ &\prod_1 P(\varepsilon_i > -\beta' X_i - 1/\lambda, v_i > -\alpha' Z) \cdot f(y_i / \varepsilon_i > -\beta' X_i - 1/\lambda, v_i > -\alpha' Z_i) \cdot \end{aligned} \qquad \text{Eq. 18}$$

When $\lambda = 1$ we obtain the standard DHD model. Note that the transformed *error* in the Box Cox model:

$$B(y_i^*) = \frac{y_i^\lambda - 1}{\lambda} = \beta' X + \varepsilon_{i_{BoxCox}}^* \qquad \text{Eq. 19}$$

cannot be normally distributed since the transformed y^* is only defined for $y^*>0$ and hence a truncated normal distribution must be assumed.[39] This would be an innocuous restriction when analysing household expenditure data since restricting y^* to positive values would be reasonable. For WTP data however, such a restriction would be in some cases unjustified since respondents may yield disutility from a specific policy change and thus would wish to express a negative WTP. In order to allow for negative WTP values we utilise the Inverse Hyperbolic Sine (IHS) Transformation of y^* (see Johnson, 1949):

$$I(y_i^*, \theta) = \sinh^{-1}(\theta \cdot y)/\theta = \ln\left(\theta \cdot y + \left(\theta^2 \cdot y^2 + 1\right)^{1/2}\right)/\theta = \beta' X + \varepsilon_{i_{IHS}}^* \qquad \text{Eq. 20}$$

which produces the model:

[39] Yet see Burbidge *et al.* (1988) on how the Box-Cox transformation can be adapted to allow for negative values of y^*.

$$I(y_i, \theta) = I(y_i^*, \theta) \quad \text{if} \quad y_i^* > 0$$
$$I(y_i, \theta) = y_i \qquad \text{otherwise} \qquad \text{Eq. 21}$$

where θ is scalar location parameter that is estimated from the likelihood function. The transformed distribution is symmetric about 0 in θ. The IHS transformation has the attractive features that it becomes linear when θ approaches zero (i.e. $\lim_{\theta \to 0}(I(y_i^*, \theta) = y_i^*)$ while for relatively large values of y and a large range of values for θ, the transformation behaves logarithmically (Burbidge *et al.*, 1988, Reynolds and Shonkwiler, 1991, Yen, *et al.,* 1996). The likelihood for the IHS DHD model now becomes:

$$L_{IHSDD} = \prod_0 \left[1 - \Phi\left(\alpha' Z_i, \beta' X_i / \sigma_\varepsilon, \rho_{\varepsilon,v}\right)\right]$$
$$\prod_+ \Phi\left(\alpha' Z_i, \beta' X_i / \sigma_\varepsilon, \rho_{\varepsilon,v}\right) \cdot \prod_+ \underbrace{f\left(y(\theta) / y > 0, I > 0\right)}_{\text{truncated bivariate IHS distribution}} \qquad \text{Eq. 22}$$

Two obstacles hinder the maximisation of the corresponding log-likelihood ($\ln L_{IHSDHD}$). First, a bivariate normal distribution has to be evaluated. This is common in all models that assume dependence. Second, the log-likelihood of the IHS model in particular is highly non-linear in θ and in fact the function tends to flatten out as $\theta \to \infty$. The current application follows the estimation approach outlined in Reynolds and Shonkwiler (1991) while the code was programmed in Intercooled STATA Version 6.

An additional attractive feature of both the Box Cox and the IHS transformations is that they can be used in conjunction with 'fix-ups' for heteroscedasticity such as the parameterisation of the variance (Reynolds and Shonkwiler, 1991). Following the prescription found in Maddala (1983) Poirier (1978) and Yen (1993) the variance of y^* is modelled as a function of a constant and various explanatory variables, such that:

$$\sigma_\varepsilon = \delta_i' W_i \qquad \text{Eq. 23}$$

where W is a set of explanatory variables that are included in the vector X (i.e. the determinants *of* y_i^*) and γ is its corresponding parameter vector.[40] By imposing the relevant restrictions on the Box-Cox and IHS double hurdle dependent models it can be shown that they nest the Box-Cox and IHS independent and Tobit models as well as the full range of standard (non-transformed) Tobit models presented in Section 4.5. [41] Annex 2 presents the likelihood functions of these models in more detail. Figure 4.1 and Figure 4.2 in Annex 1 displays how these models are nested. Finally, Annex 3 contains the programme code created to estimate the models in STATA 6.

4.7. An application of a generalised limited dependent variable model on WTP data for non-use values.

The generalised limited dependent variable approach discussed above was applied to a payment card WTP data set obtained from a CV study that investigated individual preferences for the conservation of the Giant Panda.[42] As shown below the data returned a relatively large and diverse number of zero WTP responses. Applying the generalised LDV modelling approach we use series of nested and non-nested test to determine the parametric model that best accommodates the qualitative differences among zero WTP responses. Models where sample separation is and is not possible are estimated. Further, the violations of the normality and homoscedasticity assumptions are explored and addressed. Finally, the lack of sufficient

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[40] Note that this is a deterministic specification of sigma.

[41] As noted such an approach has not received much attention in CV data analysis. Many researchers have used alternative distributional assumptions when estimating CV data to account for non-symmetrical distributions of WTP (Clinch and Murphy, 2001). Recently Clinch and Murphy (2001) have suggested that researchers utilise general distributions that include the normal as special case. They conclude by saying:
"... mean WTP figures from contingent valuation studies can be quite sensitive to the econometric specification. Clearly, policy should be based on robust results. Accordingly we recommend that the sensitivity of contingent valuation results be examined using a range of models including hurdle type models as well as a range of distribution functions ..."(p.441). The approach taken here does exactly this!

[42] WTP from payment cards are can also be viewed as a limited dependent variable but with multiple censoring points. The generalised hurdle model for continuous data can be used with interval data (by using the lower bound or the mid point value) if the intervals are sufficiently narrow (Blundell and Meghir 1987; Cameron and James, 1987). If this is not the case then a modification of the log-likelihood function needs to be undertaken to account for the multiple censoring points (see for example Clinch and Murphy for a hurdle model with interval data). Since using the multiple censoring version of the IHSDHD would complicate the estimation task, we first assessed whether the complex version is necessary in the first place. This was accomplished by comparing the continuous Tobit with the interval Tobit specification. The parameter results (not reported here) were almost identical across both models. This implies that the intervals of the payment card were sufficiently narrow for the continuous version of the models to be used.

understanding of demand for pure public goods (such as species conservation) justifies the use of such a cautious and permissive approach to choosing the appropriate econometric specification that best accounts for the data generating process.

The details of the CV study are discussed in greater detail in the next chapter. Here we focus on the aspects and results of the study that are most relevant for exposing the versatility and strengths of the generalised LDV modelling approach. The CV study was design, tested and implemented in 1998 in Beijing, China and sought to examine non-user preferences for the conservation of the Giant Panda. Since the Panda is such a celebrated species we focused on assessing global non-use values associated with its conservation. A total of 305 foreign tourists were interviewed in person. Respondents were informed that the Giant Panda is an endangered species with only approx. 1000 animals remaining in existence in total. Respondents were informed of the reasons behind the plight of the Panda and of the unsuccessful conservation efforts that have been used in the past. The conservation scenario focused on the Wolong Panda Reserve, which is a nature reserve that hosts the largest single number of pandas (200). The aim of the programme would be to increase the number of pandas from 200 to 500 animals which is considered as the minimum viable population (Mackinnon *et al.*, 1989; Schaller, 1993). Under this programme the species would be conserved in captivity (cages) since the forces leading to habitat destruction would not be addressed.[43] Failure to implement the programme would lead to species extinction with certainty.[44] It was hypothesized that the values associated with this programme would include 'use' values for preserving 'panda genes' and some forms of 'non-use' values obtained from the knowledge that the species will not go extinct. Respondents were also told that the programme would be managed by the Chinese authorities in collaboration with an international conservation organisation. Finally, the scheme would be finance via an airport tax surcharge on all outbound international flights from China. WTP values were elicited using the payment card method and hence exact cost figures for the programme were not provided. Individuals would return a positive WTP value for the programme if they received

[43] This is in fact is the conservation programme the Chinese authorities have actually opted for: "China has begun to implement the Plan for the *ex situ* Conservation of Chinese Giant Pandas. The plan focuses on the captive breeding of giant pandas" (China Daily, January 5, 1999).

[44] The CV study used an advanced warning approach to obtain WTP values for two other conservation programmes. In this chapter we focus only on the first conservation programme.

positive utility from panda conservation and could afford to pay an extra airport tax. Individual who provided zero responses would reflect (i) negative values (i.e. values censored at zero) when individuals may receive disutility from the programme (e.g. some may not like the fact that the species will be conserved in cages); (ii) abstentions when the individuals may not have panda conservation in their preference function; (iii) real corner solutions when individual WTP is driven to zero for certain levels of the variables determining the WTP function and (iv) protest zeros which could be concealed corner solutions or may reflect positive values that were misreported as zeros. The generalised LDV model described above will attempt to accommodate all of these responses.

4.8. Distribution of WTP and types of zero responses obtained

The distribution of the WTP is shown in Figure 4.3. The percentage of zero responses for the Panda conservation programme was 38% (113/305). This is a non-trivial proportion of zeros and thus the use a limited dependent variable model is warranted. Before we proceed with determining for the most appropriate LDV specification it is worth discussing the reasons behind these zero WTP values as provided by survey participants in response to open-ended follow-up questions. In many cases CV analysis accept these responses at face value and do not question their honesty, at least at the same degree as they scrutinise the sincerity of WTP responses. Even if we do accept that these follow up questions are 'sincere', they still may be highly ambiguous and uninterruptible. Perhaps some follow-up responses are less ambiguous than others. For example, a responded who stated that they provided a zero WTP because they 'could not afford paying any amount' may be a plausible 'true' corner solution. Likewise a response of the sort 'I don't care about pandas' may be attributed to someone who abstains. Other responses, however, may be less interpretable in that they can classify a particular zero response as either an abstention or a corner solution. This is usually the case with follow-up responses associated with protest zeros.

Accepting for the moment that some responses are less ambiguous than others we have classified respondents with zero WTP into three groups: abstentions, real corner solutions and protests. This classification is presented in Table 4.1. Respondents with zero WTP that stated that they *' Don't Care about pandas'* or that panda conservation *'Is not an important problem'* were classified as abstentions. These constituted 33.63 % of all the zero responses. Responses of the type *'I can't afford to pay anything at all'* correspond to the interpretation of true corner solutions. These constitute only 4.42% of all zero responses. The residual category of zeros (61%) that were associated with relatively more ambiguous follow up responses were classified as protestors. It is worth stressing that this classification is highly subjective since the bleak reality is that follow-up questions can be interpretd in different ways by different analysts. Yet, the classification of zero responses is crucial for estimating sample mean WTP as well for choosing the appropriate specification for parametric modelling of WTP responses. If we take a strict agnostic stance in interpreting follow-up responses then only LDV models *without* sample separation can be used (i.e. such as those described in 4.5.1). If we do use the sample separation models of 4.5.2 we should be very cautious in interpreting the results.

Table 4.2 presents mean and median values for various classifications of zeros. The full sample, including all zeros has mean and median values of \$3.90 and \$1 respectively. Excluding all those individuals not in the market gives us values of \$4.4 and \$3. Further excluding all protestors gives values of \$6.04 and \$5. The differences between median values are statistically different from zero. Interpretation of some of the protests as corner solutions can lead to an array of different classifications and corresponding mean/median WTP figures. What is more *a priori* classification of zeros for the purpose of using the data in parametric models imposes behavioural restrictions on the data that may not be justified.

As mentioned above this problem of interpreting zero responses has been encountered by micro-econometricians in the analysis of household expenditure survey and has been dealt with using the array of models described above.[45] For example the bivariate Tobit models 'internalise' the uncertainty over the nature of zero responses by allowing all forms of zeros to enter the model (i.e. no behavioural restrictions are imposed). In essence, zeros are 'classified' statistically within the estimation process. This may offer a more permissive modelling approach since it avoids the difficult task of interpreting and classifying zero WTP responses and allows the data itself to determine which models best describes the data generating process.

Further, when types of zeros can be identified, sample separation models may be applied. Such models are considered to be more efficient that models without sample separation since they include the extra/auxiliary information provided by this separation directly into the model. Applications of LDV models with sample separation have been applied in the analysis of various micro-data sets (e.g. labour supply, university enrolment, cigarette consumption etc). The success of these models, however, relies on how *accurate* zeros can be interpreted and classified. This is a huge challenge for CV designers. Still, if we are willing to (tentatively) accept that follow up questions are able to classify zeros into abstentions, corner solutions and a residual category we can employ such a sample separation models in CV data

[45] For example, many micro date sets on household expenditures cannot distinguish between abstentions, corner solutions, misreported zeros or zeros due to infrequency of purchase.

sets. Estimation results of both sets of models, with and without sample separation, are presented in the next sections.

4.9. Explanatory variables and model specification.

Table 4.3 describes the explanatory variables used the regression analysis. For ease of comparison we have used the same set of explanatory variables in all models. Also, the set of explanatory variables used for the participation and payment decisions was allowed to overlap. By construction the bivariate Tobit models allow for the possibility that a particular variable may affect each decision in different was (e.g. change of sign). Apart from conventional socio-economic variables (income, age, sex), the specification also included a range of motivational and attitudinal variables in the regression analysis. These were included so as to explore Pudney's behavioural hypothesis for the case of public goods. This asserts that the participation decision mainly depends on qualitative factors captured motivational variables while the payment decision depends on both motivational and demographic characteristics of the individual. Including such variables in choice models has been recommended both by the NOAA panel in order to assess the internal validity of CV responses (Arrow *et al.* 1993, p.4609, Bateman *et al.* 2002)[46] as well as by an increasing number of choice modellers in order to better explain individual decision making processes (e.g. McFadden, 1987; Ben-Akiva *et al.*, 1997).

Economic Variables

The economic variables used were income (in logarithmic scale), respondent age (in years) and gender (*male=1*). An additional index was constricted to capture individual trust for the success of the programme. The 'income' and 'programme' variables are hypothesised to mostly affect the payment and not the participation decision. The 'programme index' may be interpreted as operating similar to a price variable. People who abstain will be out of the market no matter their perception of the success of the programme (similar to cases where people abstain from consuming a particular good irrespective of its price).[47]

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[46] Langford *et al.* (2000) have shown that that attitudinal indexes, as opposed to socio-economic or demographic indicators, can in many cases be the primary driver of stated values. Despite this the emphasis in many CV studies has been upon the latter at the expense of the former, an approach which seems unbalanced given the paucity of clear and definite expectations afforded by economic theory (see Bateman *et al.* 2002 for a discussion).
[47] Survey data on individual characteristics (such as income) are often incomplete. This was not a relatively serious problem with the current data set where income non-response was only 1.6%. These observations were

Motivational Variables
In contrast motivational variables are hypothesized to affect both the participation and payment decisions. It is generally agreed upon that motives for use values are utilitarian in nature. The literature discussing non-use values has identified three motives that influence non-use values: self-interest, sympathy and commitment (Kopp, 1992). Little consensus, however, exists as to which of the motives is more important. For example, authors such as Sagoff (1994) and Spash (2000) would argue that a sense of commitment is what motivates non-use values, Randall (1993) would argue for sympathy, while Carson *et al.* (2000) for self-interest motives. We examined various motivational variables and allowed for the possibility that all three motives may influence non-use values. This is in line with Sen's arguments that self-interest, sympathy and commitment motives may equally play their role in determining individual preferences for public goods (Sen, 1977).

Individual motives as latent variables describing one's preference function can be considered to be exogenous variables in that they are not strictly speaking 'chosen'. Instead they are the outcome of one's social up bringing, interaction and experiences. Proxy indexes were used to represent the effect of these latent motives on the participation and payment decisions. These were constructed using factor analysis. A series of behavioural and attitudinal questions were asked in the first sections of the survey which were used in the factor analysis. The results of the factor analysis extracted three motivational indexes: (1) a general 'welfare' index reflecting ones general concern for panda conservation, (2) 'sympathy' index reflecting one's empathy or compassion for animals and (3) a 'ethics' index signalling one's sense of moral obligation to conserve wildlife. In addition to the motivational indices constructed *indirectly* via the factor analysis we also constructed an alternative index *directly* from answers to questions that asked respondents explicitly to reveal their motives for willing to pay for panda conservation. These motives ranged from a desire to preserve genetic material (leading to indirect use values) to a sense of moral duty to preserve wildlife (leading to non-use values).[48] The results were coded and a use/non-use value index was constructed on the basis of the coded responses. This is an

omitted from the analysis. In situations where income non-response is larger omitting these observations may bias the sample. See Alvarez-Farizo *et al.*, (1999) for a selection model that accounts for high percentages of income non-response.

index which captures the *relative* importance of gene conservation (i.e. use) over animal welfare (i.e. non use) concerns. The index ranges from 1 to 5 and was constructed such that as it increases the relative importance of use value motives over non-use motives increases (these motivational indexes are discussed in more detail in the next chapter).

Parameterising σ_i

Following Maddala (1983) we account for heteroscedasticity by allowing the standard deviation σ_i to vary across observations. This was achieved by parameterising σ_i. Various combinations of variables were attempted. The specification that produced the greatest improvement in the log-likelihood was adopted (see below).

4.10. Estimation Procedure.

Full information maximum likelihood (FIML) was used to estimate all the models shown in Figures 4.1 and 4.2. We initially estimated the first hurdle dominance model to examine if zero observations lead to sample selection bias. This would be the case when respondents that stated zero WTP somehow systemically differ from those who stated a positive WTP. Three different forms of selectivity bias were examined. Sample selection bias due to all types of zeros, sample selection bias due to the abstention zeros and sample selection bias due to reported zeros from individuals not abstaining. In all cases the correlation coefficient, ρ, between the participation and payment decision is highly *in*significant. This implies that we do not have a sample selection problem.[49] This also tests for the validity of the assumption of first hurdle dominance and is equivalent to a likelihood-ratio test between the first hurdle and complete dominance models. Both the *t*-test on ρ and the LR-test suggest that the process generating zeros should not be addressed with a selectivity model. The results from these tests do not rule out the dominance assumption altogether. All they show is that the zero responses do not lead to selectivity problems. Also, the insignificance of ρ implies that a complete

[48] Note that all use values were excluded by the nature of the conservation programme.

[49] In fact many CV studies have found that selection models tend to be inferior to bivariate or univariate Tobit models since they do not account for the censored nature of the data (i.e. that the WTP distribution is censored at zero.

dominance model could be used. Yet, as explained in Section 4.5 dominance is a behaviourally restrictive assumption since it implies that there is no level of the variables affecting WTP that could drive WTP to zero (i.e. it precludes corner solutions). Hence, the remainder of the paper will focus on the univariate and bivariate (hurdle) models that allow for all types of zeros.

Initially the untransformed versions of these models with constant variances were estimated with and without sample separation (i.e. the DHD, DHI and Tobit models). The log-likelihood values that were used to construct LR tests are listed in Table 4.4. Then diagnostic tests were performed to examine the validity of the normality and homoscedasticity assumptions. Violations of these assumptions where addressed with transformation of the dependent variable and parameterisation of the variance of the WTP equation. Further diagnostic testing showed that both the IHS and Box-Cox transformation (along with appropriate parameterisation of the variance) adequately 'corrected' for violations of these assumptions (Table 4.5, Table 4.6, and Table 4.7). The two transformed models were then compared on *a priori* and statistical grounds. The IHS model proved to be superior on both accounts and was used for discussing the behavioural implications of the parameter estimates in greater detail.

4.11. Hypothesis Testing and model selection.

The validity of parameter estimates and of the LR tests that compare nested models is highly dependant on normality and homoscedasticity assumptions. Two diagnostic tests were used to examine the validity of these assumptions. First, the information matrix (IM) test developed in Chesher (1984) was used to jointly test for homoksedasticity and normality. The construction of the test statistic followed the approach described in Reynlods and Shonkwiler (1991), Gao *et al.* 1995 and Green (1997). The procedure involves running an auxiliary least squares regression of a column of ones on a matrix whose elements are functions of first and second derivatives of the log-likelihood. The IM test-statistic is the sample size N times the R^2 obtained from this auxiliary least squares regression and follows a Chi-square distribution. We also employed a RESET misspecification test as suggested by Yen and Jones (1996). This test included second and third powers of the fitted values for the continuous dependent variable as extra regressors in the WTP equation (Yen and Jones, 1996) .

Likelihood ratio tests suggest that the DHD outperforms the models it nests (i.e. the DHI and Tobits models) (see Table 4.10 and Table 4.11). Yet these test are not valid if non-normality and heteroscedasticity are not addressed. The results of the IM test on the DHD model suggest that the null of joint normality and homoscedasticity was rejected at the 5% level. What is more, the RESET test also suggested that misspecification is present (the null is rejected at 0.5% with $df = 2$) (see Table 4.5).

Experimentation with various explanatory variables suggested that the variance was not constant over households. Various combinations of variables were attempted. The specification that produced the greatest improvement in the log-likelihood was adopted. This constitutes of the age and sex variables (together with a constant term):

$$\sigma_i = \delta_0 + \delta_1 Age + \delta_0 Sex \qquad \text{Eq. 24}$$

This specification of σ_i improved the fit of the model. The likelihood-ratio test under the null hypothesis that the coefficients on age and sex are jointly equal to zero (i.e. $H_o = \delta_i = \delta_i = 0$) is rejected at the 0.5%.

We then re-ran the untransformed models using the above parameterisation of the variance term. Employing again the IM test we reject the hypothesises that the untransformed models are correctly specified. This implies that the presence of non-normality was suspected. A Lagrange Multiplier (LM) test developed by Bera *et al.,* (1984) and Gao *et al.,* (1995) rejects the normality of the participation and payment decisions at the 1% level (chi-square statistic is 57.69). Also, the RESET test once again rejected the null hypothesis that the untransformed models were correctly specified. All these findings suggest that though the LR-test between untransformed models indicate that the DHD model outperforms the DHI and Tobit, the tests cannot be trusted on account of the violation of the normality assumption documented above.

To address the non-normality of the DHD model, we employed the IHS and Box-Cox transformations of the continuous dependent variable and re-estimated the models. Due to the highly non-linear nature of these log-likelihood functions a more sophisticated algorithm was used to step through the non-concave regions of the likelihood. The procedure employed varied how the direction of the step or iteration is found when a negative Hessian (- H) cannot be inverted and thus the usual way of calculating the direction of the next step cannot be performed. The procedure consists of computing the eigenvalues of $-\mathbf{H}$ and then for parts of the orthogonal subspace where the eigenvalues are negative or small positive numbers the procedure uses steepest ascent and in the other subspace uses regular Newton-Ralphson step. (see Gould and Sribney (1999) for details). In addition, initial values had to be specified to guide the convergence process. Staring values for the IHSDHD model were determined as prescribed by Reynolds and Shonkwiler (1991).[50]

Performing the LR test on the transformed models we find that that the model that assumes dependence between the participation and payment decisions outperforms the other two models (i.e. IHSDHD outperforms the IHSDHI and IHS Tobit while the BCDHD outperforms the BCDHI and BCTobit). More importantly, both the IM and RESET test on IHSDHD and BCDHDH (see Table 4.5) could not reject the null of correct model specification. Also note that the coefficients of the parameters of sigma (namely 'age' and 'sex') are all significant (see Table 4.12 and Table 4.13). This implies that the transformed models are void of non-normality and heteroscedasticity problems.

A similar procedure was followed in the estimation of the composite model with sample separation. Once again, transformation of the dependent continuous variable and parameterisation of the WTP equation was required to account of non-normality and heteroscedasticity problems. As can be seen by Table 4.8 the HIS and Box-Cox hypotheses could not be rejected (i.e. the hypotheses that $\theta = 0$ and $\lambda = 0$ was rejected in all cases). Further, we can see from Table 4.16 that we can reject the hypothesis of dependence (i.e. the hypothesis that $\rho = 0$).

The above results highlight the versatility of the generalised LDV modelling approach presented in this paper. In line with the results from many other CV studies we find that mixture models that include a separate participation decision outperform univariate Tobit models. Yet, the results also show that the assumption of independence between the participation and payment decisions, which has been evoked in all known CV applications of the hurdle model may not be always warranted. The dependence in error structure implies that

[50] First we estimated the parameters of the Tobit and then used these as starting values for Eq. 22 along with a

individuals are making the participation and payment decisions simultaneously, which is consistent with decision that concern relatively small percentages of household income.[51] Also, correlation of the error structure may result from uncertainty about the functional form of the conditional indirect utility function since there may be unobservable factors that increase an individual's probability of participating (e.g. latent conservation motivational and attitudinal characteristics) which may also increase the amount one would be willing to pay (Johansson, 1999).

4.12. Parameter Estimates.

Assessing the impact of the regressors on the probability of stating a positive WTP and on the observed WTP bid is complicated by the dependence between the two decisions and by the non-linear transformation of y*. As a result the *magnitude* of the raw-coefficients are difficult to interpret. This section reports on the direction and significance of the parameter estimates while the marginal-effects of the regressors (magnitude of parameters) on the various decisions of the models are discussed in the next section.

First examining the estimates from the DHD, DHI and Tobit models without sample separation we see that the sign and significance of parameters is quite similar across models. This holds for both the IHS and Box-Cox versions of the models (see Table 4.12, Table 4.13 and Table 4.14). The results of the participation decision provide mixed signals as to what affects abstention. While higher scores on the 'animal welfare' indexes suggest a higher probability of participation the parameters on 'sympathy' and 'ethics' indices suggest the individual with higher empathy towards animals and with high sensitivity to animal right issues will be less likely to participate in this market. The results on the payment decision from these models suggest that motivational variables affect the magnitude of one bids in the

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positive starting value for the IHS parameter.

[51] The Engel's curve (expenditure) literature has found that the dependence is associated with goods that take up small amounts of household budget, such as foods, (e.g. Gao *et al.* 1995) while the opposite is the case for goods such as durables (e.g. Blundell and Meghir 1987). Also, Yen *et al.* (1995) use hurdle model to analyse revealed preference donations data (for environmental conservation) and find that the dependence assumption is warranted. Hence, analysis of CV data should not impose independence *a priori.*

same direction as that observed in the participation decision. Also, the coefficient on the USE/NUV index also confirms prior expectations, with individuals with relatively higher use motives to be more likely to participate and pay more for such a programme (that entailed primarily indirect use-services and very low non-use flows). Finally, the programme index and income variable had a positive and significant impact on the payment decision across all models.

Choice between the IHS and Box-Cox models can be based both on *a prior* and statistical grounds. The IHS model allows for a more flexible transformation of y^* and allows for negative values of y^* (Yen 1996, Yen and Jones, 1997). This may be particularly useful for the current data set where WTP could plausibly have been negative had such values been elicited. The programme valued, though presented as necessary for panda's conservation, did involve conservation of this cherished species in cages. This could have plausibly evoked negative values. Moreover Yen (1996) shows how the two models can be compared on statistical grounds using a non-nested LR test developed by Vuong (1989). We utilised the test for 'strictly non-nested model's which follows a standard normal distribution.[52] The t-statistic is $z=5.74$ and hence we can reject the hypotheses that Box-Cox DHD model is preferable over the IHS DHD (p-value<0.001).[53] Hence, we shall use the results from the IHS models to compare model with and without sample separation.

Estimates of the IHS DHD model with sample separation are presented in Table 4.16. Looking at the participation decision in this model we find much more clear support for Pudney's model of discrete random preference regimes. All the motivational indexes affect participation in the same direction while the economic variables of income and 'programme index' are not significant. Hence, participation may be reasonably modelled as a discrete shift altering the nature of individual preference. The decision may be viewed as being 'non-economic' in nature.

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[52] This corresponds to Equation 5.6. in Vuong (1989).

[53] Applications of the Vuong test for double hurdle models may be found in Yen (1996), Su and Yen (1996), Blisard and Blaylock (1993), and Kimhi (1999). The test has also been applied to examine non-nested CV discrete choice models in Genius and Strazzera (2001). An alternative approach for comparing the IHS and Box-Cox transformations that has been suggested is the DLR hypothesis testing approach (see Burbidge *et al.*, 1988;

Turning to the 'reporting' decisions, we see that market participants are more likely to report a zero WTP the higher they score on the 'commitment' and 'sympathy' indices. This suggests that the reasons behind 'protest' behaviour may be attributed to ones ethical and emotive dispositions towards animals that are somehow compromised by the current conservation scenario. The results of the reporting decision are in fact similar to those of the participation decision *without* sample separation. This indicates the participation decision in the models without sample separation may have been picking up 'mixed' effects from market non-participants and from 'protestors'. The results from the model with sample separation suggest that these two types of zeros are explained by different variables or rather, by the same variables but in different ways. Disentangling and separately accounting for these qualitatively different types of zeros is thus more informative as to how and why people make their final WTP decisions. The (trivariate) composite model showed that motivational variables affect the likelihood of abstaining in the same direction indicating that the individual which are 'not in the market' have quite distinct and heterogeneous preferences than market participants.

Turning to the effects on the payment decision under sample separation we see that the results are similar with those obtained from the models without sample separation. This suggest that positive bids and true zeros (corner solutions) are equivalently explained with and without sample separation.

Finally, it is worth noting that the sign of the correlation coefficient between the reporting and WTP functions is positive and significant. Hence, the likelihood of reporting a positive bid increases with the amount of the bid stated. This may provide some support that some of those individuals reporting a zero WTP (once in the market) may in fact have a very low latent WTP value.

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and Davidson and MacKinnon, 1984). Yet, the procedure is considerably involved while its results are merely indicative.

4.13. Estimated expected WTP, income elasticity of WTP and predicted probabilities.

The general form of the E(WTP) for LDV models that includes information from both limit (zero) and non limit (non-zero) observations is given by (see Bockstael, McConnell and Strand, 1991):

$$E(y) = P(y > 0) \cdot E(y / y > 0) \qquad \text{Eq. 25}$$

For the preferred model, IHSDHD, this expression is quite complicated since it involves the IHS transformation of the bivariate truncated distribution and is given by (Yen *et al.,* 1995):

$$E(y_i) = \int_0^\infty y_i \cdot (1 + \theta^2 \cdot y_i^{\,2})^{-1/2} \times \frac{1}{\sigma_\varepsilon} \cdot \phi\left[\frac{I(y_{ii}, \theta) - \beta' X_i}{\sigma_\varepsilon}\right] \times \Phi\left[\frac{\alpha' Z_i + \rho_{\varepsilon,\nu} \cdot \left(\frac{I(y_{ii}, \theta) - \beta' X_i}{\sigma_\varepsilon}\right)}{\sqrt{1 - \rho^2_{\varepsilon,\nu}}}\right] \qquad \text{Eq. 26}$$

The corresponding expressions for Box-Cox DHD model is included in Appendix 2. The estimated expected unconditional WTP estimates of the transformed and untransformed models (with and without sample separation) are shown in Table 4.17. The results show that the IHS figures lie between the Box-Cox and untransformed counterparts. As explained above, the E(WTP) results obtained from parametric models have a secondary role in light of the more robust non-parametric estimates. Yet, parametric models still have a vital contribution in providing information on key elasticity values and predicted probabilities. To estimate the latter we must first assess the marginal effect of a change in an explanatory variable on the participation and on payment decisions. The 'raw' parameter estimates discussed in the preceding section do not provide the true marginal effects since these merely refer to the *latent* variables of the model. Instead we must evaluate the derivatives

$\partial[\Phi(\bullet)]/\partial x_i$, and $\partial E[y_i]/\partial x_i$. For the Tobit model (that does not have a participation decision) the effect of an explanatory variable x on the censored distribution of WTP is given by $\Phi(y>0)\cdot\beta_x$.[54] Yet, the 'pure' effect of an explanatory variable x on WTP is confound by the fact that the Tobit model assumes that the probability of proving a non-zero response and the magnitude of the WTP bid are determined by the same function. Following the simple procedure of McDonald and Moffitt (1980) we find that for an equi-marginal change in all dependent variables when initially set at their mean values, the impact of an explanatory variable on the probability of submitting a non-zero response is 37% with the remaining 63% corresponds to the impact of the size of the WTP bid conditional on stating a positive bid. Also holding all explanatory variables constant and considering a change in income (when initially set at its mean value) produces a similar decomposition of the marginal effect (42% for the participation and 58% for the payment decision).[55] This 'purified' marginal effect of income on WTP can then be used to construct income elasticity of WTP.[56]

Obtaining a decomposition of the effect of explanatory variables such as income on the probability of participation and on the level of WTP is much more involved for the hurdle models and even more so for the transformed hurdle models. Convenient (albeit cumbersome) expressions for these marginal effects are available for the Box-Cox and untransformed hurdle models. For the IHS models such convenient expressions for these derivates do not exist and hence we must use numerical methods. For the latter we followed the approach of Yen *et al.* (1995) while the estimated asymptotic errors were estimated using the delta method (numerical differentiation and integration was undertaken in STATA). Marginal effects were calculated for income (evaluated at mean levels) only for the WTP decision since income was not found to be significant in any of the participation or reporting decisions. These were then used to calculate income elasticities of WTP for models with and without sample separation. We see from Table 4.18 that the (restricted) untransformed models that have been used in most CV studies yield substantially higher elasticity values (approximately between 0.5-1)

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[54] And not simply β which is the effect on the latent uncensored WTP distribution. Examining these marginal effects are usually of less practical significance since we never observe the real latent distribution of WTP.
[55] Other applications of the McDonald and Moffitt decomposition procedure on Tobit estimates from OE-type CV data can be found in Mourato, Kontoleon and Danchev (2002) and Alvarez-Farizo (1999).
[56] Note that the composite marginal effect would lead to an over-estimation of income elasticity of WTP (by 42%).

while the IHS models (approximately between 30-40). This disparity should not be generalized since there is nothing in the transformed models that necessitate that they should yield smaller elasticity values. Yet, the income elasticity values presented here are smaller than those reported in other studies (see Mourato, Kontoleon and Danchev, 2002) and hence further research on the magnitude of these parameters is warranted.[57]

Finally, the richness of the information obtained from CV data by virtue of utilising the models presented in this paper can be further illustrated by estimating the probabilities for the various types of zero observations. The behavioural models underlying the statistical specifications allows direct estimation of the probabilities of abstaining from the contingent market, of being a corner solutions and of misreporting zero when in fact latent WTP is non-zero. Thus we see from Table 4.19 and Table 4.20 that when sample separation is not possible the probability of abstention is 26% while that drops to 13% in the sample separation models. The probability of being a corner solutions is not affected by sample separation. Yet, sample separation allows for estimation of the probability of misreporting, which is 17% of all potential demanders.

[57] Note that the low income elasticity of demand does not necessarily imply low income elasticity of WTP. Flores and Carson (1997) clarify that the former captures the effect of a change in income on quantity demand while the latter captures how WTP *for a fixed quantity of the good* changes as the results of a change in income. Flores and Carson show that for any fixed value of the income elasticity of demand, the income elasticity of WTP can differ significantly in magnitude and will in many cases be substantially less than one, a result which conforms to empirical findings (see Bateman *et al.*, 2002).

4.14. Conclusion

Open-ended type WTP data are prone to contain a large percentage of zero responses. This has lead CV practitioners to use limited dependent viable models to account for the censored nature of data and differences between limit (zero) and non-limit (non-zero) observations. The current chapter provided a contribution to the parametric analysis of such data by presenting a generalised limited dependent variable modelling approach that aimed at addressing some of the shortcomings of earlier applications. The rationale of this approach is that zero responses are not qualitatively the same but may include both abstentions and corner solutions. Moreover some zero responses may be protest zeros. Yet, accurate identification of zeros, which is required for selection of the appropriate model, is often not possible. The presentation showed how models with and without identification of protest zeros can be formulated, discussed their behavioural implications and how each set of models accounted for various types of zero responses. The generalised LDV modelling approach was applied to payment card data obtained from a CV study examining non-use values for the conservation of the Giant Panda. We then employed the general econometric approach by first estimating a model that imposes very few behavioural restrictions on the types of zeros that are permitted in the model and on the relationship between the participation and payment decisions. Then by imposing successive behavioural restrictions we used nested and non-nested test to allow the data itself to suggest the most appropriate model. This contrasts with the common practice in many CV studies of *a priori* model selection, often based on arbitrary identification and classification of types of zero responses. The rationale behind the permissive and exploratory approach presented in this chapter is similar to that found in the analysis of household survey data where the dependent variable often contains a large proportion of qualitatively zero responses that are difficult to classify (e.g. Blundell and Meghir, 1987).

Further, we postulated that the family of LDV models explored in this chapter were based on Pudney's (1989) discrete random preference regime model. This provided a behavioural rather that statistical foundation of the models and allowed for a less *ad hoc* specification of the parameters affecting the participation and payment decision. For example, under this conceptual framework the decision to participate or abstain is less of an economic decision but instead is more strongly determined by motivational and attitudinal characteristics. In contrast, the payment decision may be affected by both attitudinal and economic variables of the individual or the good itself.

Moreover, diagnostic tests suggested that the assumptions of normality and homoskedasticity were violated. This would invalidate all inferences and hypotheses testing made from the models. To account for non-normality we explored two alternative transformations of the dependent variable, the Box-Cox and the Inverse Hyperbolic Sine transformations, while we parameterised the variance in order to account for heteroscedasticity. The IHS formulation was found to outperform all other nested specifications while the parameterisation of the variance was found to be necessary to account for heteroscedasticity. The assumption of independence between the participation (or reporting) and payment decision was rejected. The results suggest that such bivariate Tobit models can be used to account for all forms of zero and positive responses, motivated by a wide range of motives. Abstentions were found to be the outcome of a separate random shift dictated by non-economic factors. Reporting a positive WTP, once in the market, was also found to be affected by such variables but in a more complex manner. The magnitude of a WTP bid was affected by qualitative variables as well as by economic variables such as income and one's trust in the programme. Finally, the results show that not accounting for dependence between participation (or reporting) and the payment decisions as well as neglecting to account for non-normalities and heteroscedasticity highly affects the estimated elasticities. This could have adverse implications when using these results for policy or benefit transfer purposes.

No doubt more research is necessary to understand which model is most appropriate under different policy situations. This would involve gaining a better understanding of the workings of each component decision (participation Vs. payment) as well as the determinants of different forms of zero responses. This implies that CV design and analysis would benefit from developing better means of identifying different types of zero responses. Moreover, multidisciplinary research may focus on determining appropriate psychometric questions that would capture the effect on participating and protesting.[58] Finally, the results from parametric

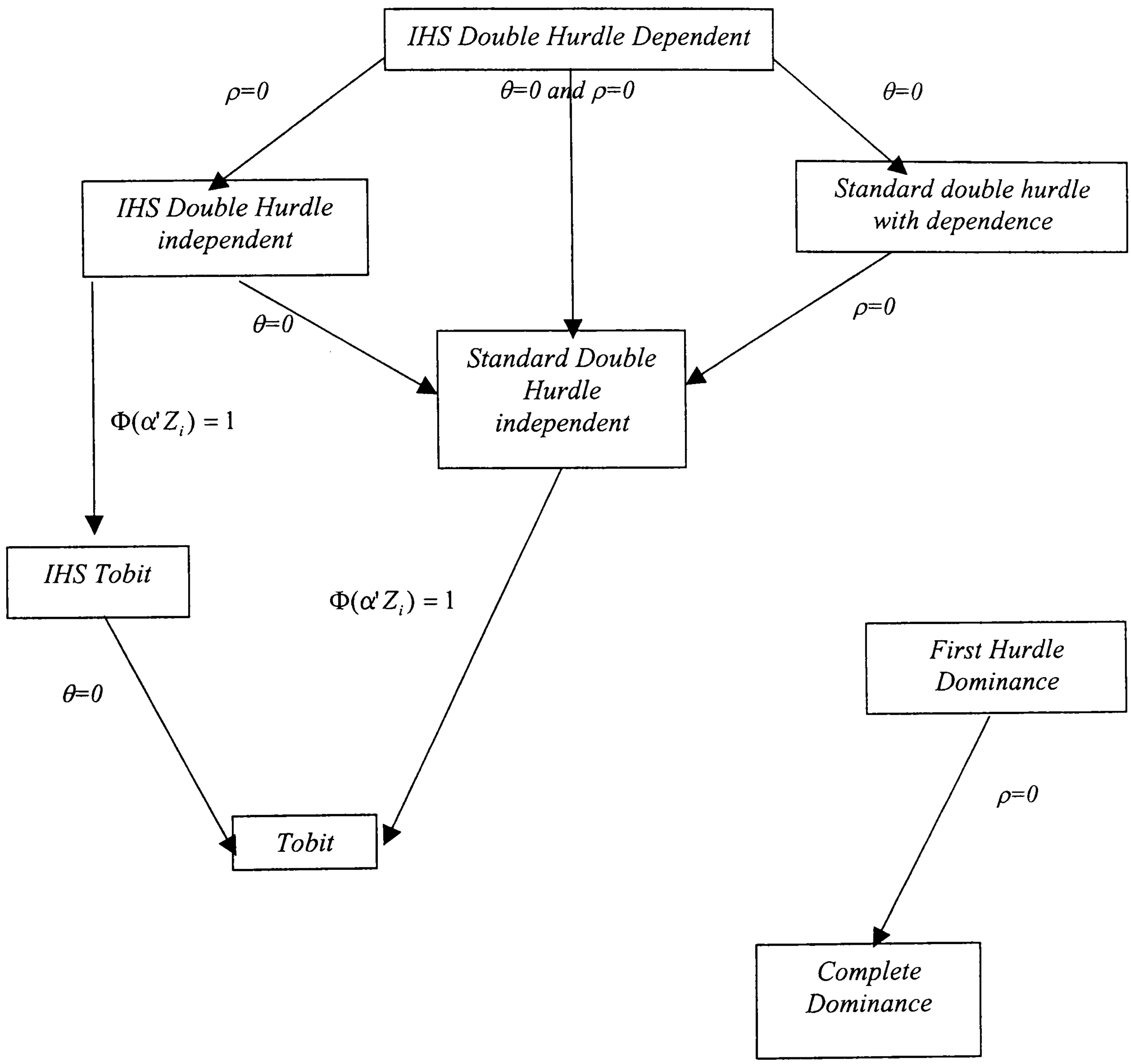
[58] There have been some attempts to understand the attitudinal determinants of protest responses. For example, Dziegielewska (2002), Spash (2002), Dalmau-Matarrodona (2001) Kotchen and Reiling (2000), Jorgensen and

models are heavily reliant on the behavioural and distributional assumption made. Hence, further experimentation with different behavioural restrictions under alternative WTP transformations is warranted.

Syme (2000), Jorgensen *et al.* (1999), Lindsey (1994), Hanley and Milne (1996). Yet, more multidisciplinary work in this field is required.

4.15.Appendix 1. Tables and Figures.

Figure 4.1 Nesting of the HIS limited dependent variable models



Note: θ is the IHS location parameter.

Figure 4.2. Nesting of the Box Cox limited dependent variable models

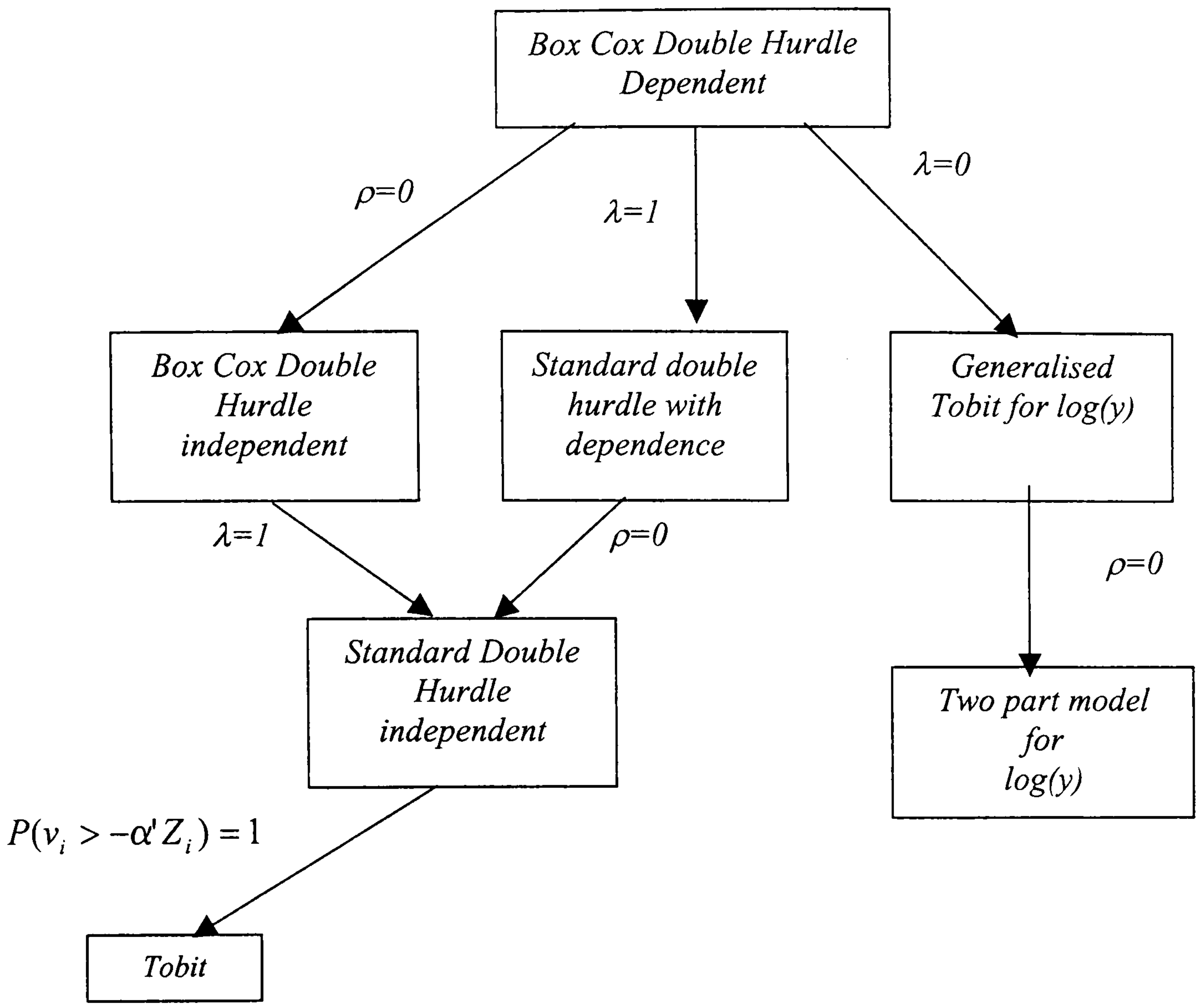


Figure 4.3. Distribution of WTP.

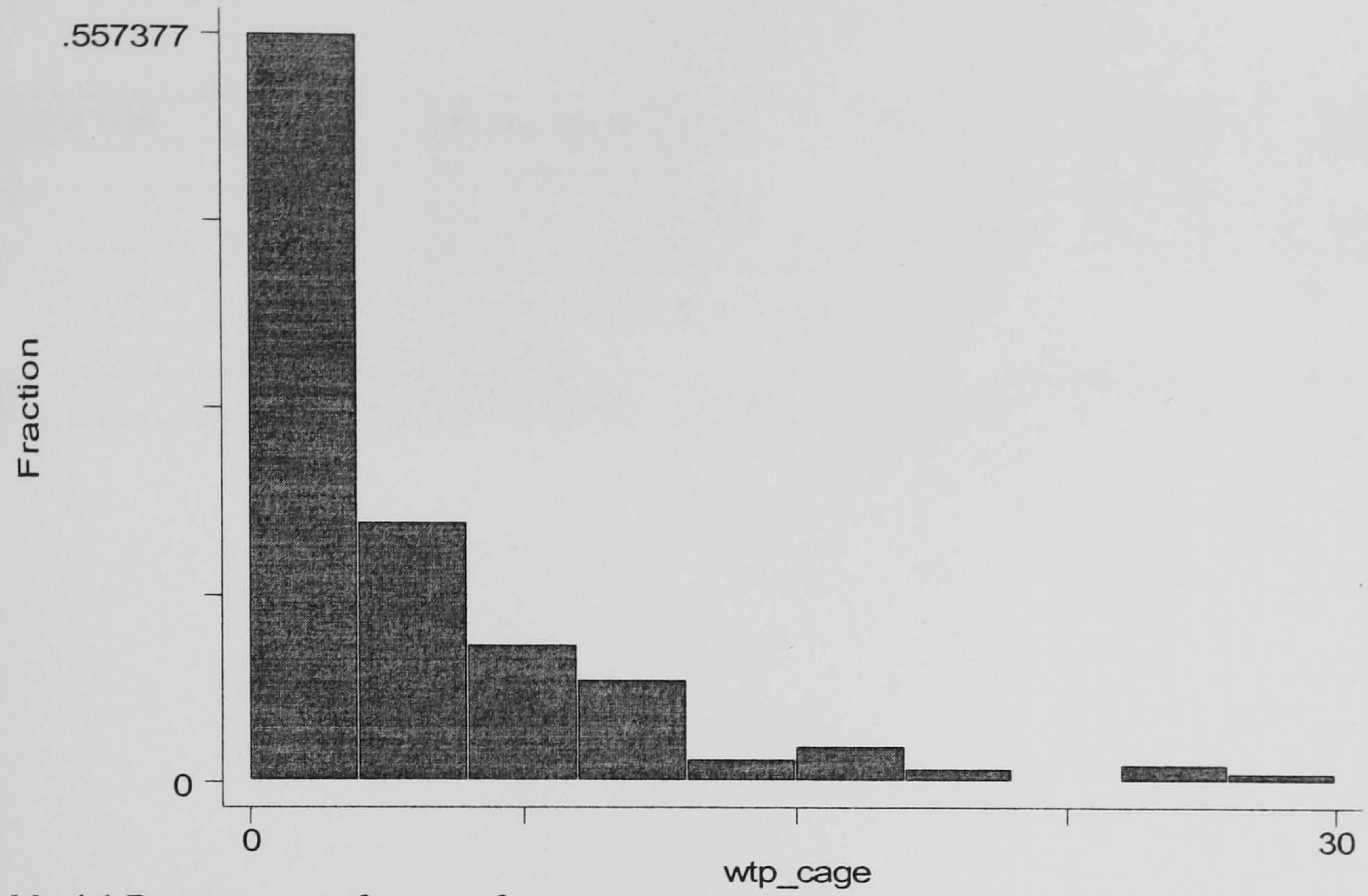


Table 4.1 Percentages of types of zero responses

	Frequency of Zeros	% of Zeros	% of Sample
Abstentions: *'Don't Care'* *'This is not an important problem'*	38	33.63%	12.46%
Corner solutions: *'I can't afford to pay anything at all'* *'This is what the* programme is worth to me'	5	4.42%	1.64%
Protests: *'It is cruel to keep pandas in cages'* *'You can't put a price on nature'* *'Let China pay for it'* *'The tax is not fair'* *'Don't trust the programme will succeed'* *'Pandas are better-off dead than in cages'* *'I need more information'* *'The money will be wasted anyway'* *'Don't know'*	70	61.95%	22.95%
Total	**113**	**100%**	**37.05%**

Table 4.2 Descriptive Statistics of WTP

Sample Size	Treatment of Zeros	Mean	Median	Std. Dev.
305	All zeros included	3.90	1	5.34
267	Abstentions excluded	4.45	3	5.49
197	Excluding abstentions and protests (including corner solutions)	6.04	5	5.59
192	Only positive responses	6.19	5	5.58

Table 4.3 Explanatory Variables

Name of Variable	Description
Income (logs)	Personal disposable annual income in 1998 US Dollars
Sex	1=male; 0=female
Age	In years; Range 18-70
Programme Index	Index of subjective assessment of the credibility of the panda conservation programme. Respondents provided answers on five-point Likert scale to the questions: 1. What kind of support do you think the Wolong Panda Conservation Programme would receive from foreigners visiting China? 2. Do you think that the airport tax increase described above is a fair method of financing the expenses connected with the implementation of the Wolong Panda Conservation Programme? 3. To what degree do you trust the capabilities of the relevant authorities to implement and enforce conservation measures for Giant Pandas if they have adequate funding? 4. If the Wolong Panda Conservation Programme would be implemented, do you think it would attain the desired conservation objective (e.g. sustaining a population of 500 Pandas)? Calculation of index: $\left(\sum_{1}^{4} m_i\right)/5$ Range 1-5
Use/Non-use index	Index of *relative* importance of instrumental or use over non-instrumental or non-use reasons for wanting to preserve the Giant Panda. Calculation of index: $\frac{\sum \text{score of responses}}{\#\text{ of responses}}$ Range: 0-5
Animal welfare index	Factor score from factor analysis.
Ethics index	Factor score from factor analysis.
Sympathy Index	Factor score from factor analysis.

Table 4.4. Log-Likelihood values of estimated models.

	Full Sample Models	Sample separation Models*
IHS Models		
IHS DHD	-598.39	-567.85
IHS DHI	-603.50	-571.35
IHS Tobit	-660.45	-625.14
Box-Cox Models		
Box-Cox DHD	-569.07	-540.73
Box-Cox DHI	-574.45	-544.92
Box-Cox Tobit	-624.85	-591.79
Standard Models with parameterised variance		
DHD	-623.16	- 586.81
DHI	-671.85	-594.59
Tobit	-676.08	-646.90
Untransformed models without parameterised variance		
DHD	-631.69	-599.47
DHI	-635.97	-603.57
Tobit	-688.05	-658.51

Dominance Models	**Log Likelihood**
FHD without sample separation	-694.57
CD without sample separation	-694.69
FHD with sample separation Model between reporting and WTP	-651.85
CD with sample separation Model between reporting and WTP	-652.00
FHD with sample separation Model between abstentions and WTP	-881.52
CD with sample separation Model between abstentions and WTP	-881.54

**Likelihood of second component of the partitioned model.*
The LnL of the initial component, the Probit, is the same for all models (lnL = -90.388612)

Table 4.5 Results from RESET test for model misspecification: all models are double hurdle dependent.

	Chi-square Statistic	Results at α=0.5% with df=2
H_0= Untransformed DHD model with constant σ is correct specification	12.60	Reject
H_0= Untransformed DHD model with parameterised σ is correct specification	18.64	Reject
H_0= IHS DHD model with parameterised σ is correct specification	3.75	Cannot Reject
H_0= BC DHD model with parameterised σ is correct specification	3.84	Cannot Reject

Table 4.6. Hypothesis Testing of IHS transformation: full sample models

	t-test on θ				
	θ	*Standard Error*	*t-value*	*P-Value*	
Dependence Model $(\rho \neq 0)$ Testing of IHS transformation $H_0 : \theta = 0$	.1761	.0360	4.888	0.00001	Reject
Independence Model $(\rho = 0)$ Test of IHS transformation $\mathrm{H}_0 : \theta = 0$	.1819	.0383	4.741	0.00001	Reject
Tobit model $\Phi(a'Z_i) = 1$ Test of IHS Transformation $\mathrm{H}_0 : \theta = 0$	.1358	.0285	4.759	0.00001	Reject

Table 4.7. Hypothesis Testing of Box-Cox transformation: full sample models

	t-test on θ				
	λ	*Standard Error*	*t-value*	*P-Value*	
Dependence Model $(\rho \neq 0)$ Testing of IHS transformation $H_0 : \lambda = 0$	.298	.048	6.21	0.00001	Reject
Independence Model $(\rho = 0)$ Test of IHS transformation $H_0 : \lambda = 0$	.327	.071	4.62	0.00001	Reject
Tobit model $\Phi(a'Z_i) = 1$ Test of IHS Transformation $H_0 : \lambda = 0$	.350	.074	4.69	0.00001	Reject

Table 4.8 Hypothesis Testing of IHS transformation: sample separation models.

	t-test on θ				
	θ	*Standard Error*	*t-value*	*P-Value*	
Dependence Model $(\rho \neq 0)$ Testing of IHS transformation $H_0 : \theta = 0$	.2287	.0487	4.694	0.00001	Reject
Independence Model $(\rho = 0)$ Test of IHS transformation $H_0 : \theta = 0$	.2404	.0559	4.296	0.00001	Reject
Tobit model $\Phi(a'Z_i) = 1$ Test of IHS Transformation $H_0 : \theta = 0$	.1687	.0345	4.883	0.00001	Reject

Table 4.9 Hypothesis Testing of Box-Cox transformation: sample separation models

	t-test on λ				
	λ	*Standard Error*	*t-value*	*P-Value*	
Dependence Model $(\rho \neq 0)$ Testing of IHS transformation $H_0 : \lambda = 0$	.3090	.0455	6.790	0.00001	Reject
Independence Model $(\rho = 0)$ Test of IHS transformation $H_0 : \lambda = 0$	.3031	.0727	4.169	0.00001	Reject
Tobit model $\Phi(a'Z_i) = 1$ Test of IHS Transformation $H_0 : \lambda = 0$	.3080	.0728	4.230	0.00001	Reject

Table 4.10. Testing behavioural restrictions across nested models: full sample models.

	t-test on correlation coefficient ρ				LR test*		
	ρ	*Standard Error*	*t-value*	*P-Value*	χ^2	α	
IHS model $(\theta \neq 0)$ with $\sigma_i = \delta' W_i$ Test of dependent errors: $H_0 : \rho = 0$	.4504	.1534	2.935	0.003	-	-	Reject
IHS model $(\theta \neq 0)$ with $\sigma_i = \delta' W_i$ Test of dependent errors: $H_0 : f(y_i(\vartheta)/\varepsilon_i > -\beta' X_i / v_i > -\alpha' Z_i) = f(y_i(\vartheta)/\varepsilon_i > -\beta' X_i)$	-	-	-	-	10.22	0.005	Reject
IHS independence model $(\theta \neq 0)$ with $\sigma_i = \delta' W_i$ Test of Tobit Model ** $H_0 : \Phi(a' Z_i) = 1$	-	-	-	-	107.58	0.005	Reject
Box_Cox model $(\lambda \neq 0)$ with $\sigma_i = \delta' W_i$ Test of dependent errors: $H_0 : \rho = 0$	.3062	.1426	2.147	0.032	-	-	Reject
Box_Cox model $(\lambda \neq 0)$ with $\sigma_i = \delta' W_i$ Test of dependent errors: $H_0 : f(B(y_i)/\varepsilon_i > -\beta' X_i / v_i > -\alpha' Z_i) = f(B(y_i)/\varepsilon_i > -\beta' X_i)$	-	-	-	-	10.76	0.005	Reject
Box_Cox model $(\lambda \neq 0)$ with $\sigma_i = \delta' W_i$ Test of Tobit Model ** $H_0 : \Phi(a' Z_i) = 1$	-	-	-	-	100.8	0.005	Reject
Un-transformed model $(\theta = 0)$ with $\sigma_i = \delta' W_i$ Test of dependent errors $H_0 : \rho = 0$	.732	.206	2.815	0.003	-	-	Reject
Un-transformed model $(\theta = 0)$ with $\sigma_i = \delta' W_i$ Test of dependent errors: $H_0 : f(y_i/\varepsilon_i > -\beta' X_i / v_i > -\alpha' Z_i) = f(y_i/\varepsilon_i > -\beta' X_i)$	-	-	-	-	15.58	0.005	Reject
Un-transformed model $(\theta = 0)$ with $\sigma_i = \delta' W_i$ Test of Tobit Model ** $H_0 : \Phi(a' Z_i) = 1$	-	-	-	-	104.62	0.005	Reject
Un-transformed model $(\theta = 0)$ with σ constant Test of dependent errors: $H_0 : \rho = 0$	.737	0.15	4.913	0.001-	-	-	Reject
Un-transformed model $(\theta = 0)$ with σ constant Test of dependent errors: $H_0 : f(y_i/\varepsilon_i > -\beta' X_i / v_i > -\alpha' Z_i) = f(y_i/\varepsilon_i > -\beta' X_i)$	-	-	-	-	8.56		Reject
Un-transformed model $(\theta = 0)$ with σ constant $H_0 : \Phi(a' Z_i) = 1$	-	-	-	-	104.16		Reject

**All LR tests reported involve a single parameter restriction (i.e. follow the χ^2 distribution with one degree of freedom.)*

Table 4.11 Testing behavioural restrictions across nested models: sample separation sample models.

	t-test on θ				LR test		
	ρ	*Standard Error*	*t-value*	*P-Value*	χ^2	α	
IHS model $(\theta \neq 0)$ with $\sigma_i = \delta' W_i$ Test of dependent errors: $H_0 : \rho = 0$	.434	.1886	2.303	0.021	-	-	Reject
IHS model $(\theta \neq 0)$ with $\sigma_i = \delta' W_i$ Test of dependent errors: $H_0 : f(y_i(\vartheta)/\varepsilon_i > -\beta' X_i / v_i > -\alpha' Z_i) = f(y_i(\vartheta)/\varepsilon_i > -\beta' X_i)$	-	-	-	-	7.3	0.01	Reject
IHS independence model $(\theta \neq 0)$ with $\sigma_i = \delta' W_i$ Test of Tobit Model ** $H_0 : \Phi(a' Z_i) = 1$	-	-	-	-	106.6	0.005	Reject
Box_Cox model $(\lambda \neq 0)$ with $\sigma_i = \delta' W_i$ Test of dependent errors: $H_0 : \rho = 0$	.462	.2435	1.898	0.058	-	-	Reject
Box_Cox model $(\lambda \neq 0)$ with $\sigma_i = \delta' W_i$ Test of dependent errors: $H_0 : f(B(y_i)/\varepsilon_i > -\beta' X_i / v_i > -\alpha' Z_i) = f(B(y_i)/\varepsilon_i > -\beta' X_i)$	-	-	-	-	8.38	0.005	Reject
Box_Cox model $(\lambda \neq 0)$ with $\sigma_i = \delta' W_i$ Test of Tobit Model ** $H_0 : \Phi(a' Z_i) = 1$	-	-	-	-	93.74	0.005	Reject
Un-transformed model $(\theta = 0)$ with $\sigma_i = \delta' W_i$ Test of dependent errors: $H_0 : \rho = 0$	.750	0.178	4.213	0.0001	-	-	Reject
Un-transformed model $(\theta = 0)$ with $\sigma_i = \delta' W_i$ Test of dependent errors: $H_0 : f(y_i/\varepsilon_i > -\beta' X_i / v_i > -\alpha' Z_i) = f(y_i/\varepsilon_i > -\beta' X_i)$	-	-	-	-	15.58	0.005	Reject
Un-transformed model $(\theta = 0)$ with $\sigma_i = \delta' W_i$ Test of Tobit Model ** $H_0 : \Phi(a' Z_i) = 1$	-	-	-	-	104.6	0.005	Reject
Un-transformed model $(\theta = 0)$ with σ constant Test of dependent errors $H_0 : \rho = 0$	.737	0.26	2.834	0.003	-	-	Reject
Un-transformed model $(\theta = 0)$ with σ constant Test of dependent errors $H_0 : f(y_i/\varepsilon_i > -\beta' X_i / v_i > -\alpha' Z_i) = f(y_i/\varepsilon_i > -\beta' X_i)$	-	-	-	-	8.2	0.005	Reject
Un-transformed model $(\theta = 0)$ with σ constant $H_0 : \Phi(a' Z_i) = 1$	-	-	-	-	109.8	0.005	Reject

Table 4.12. Regression Results: IHS double hurdle models without sample separation.

	IHS DHD				IHS DHI				IHS Tobit			
Participation	Coeff.	Std.Error	t-stat.	P-value	Coeff.	Std.Error	t-stat.	P-value	Coeff.	Std. Error	t-stat.	P-value
Ethics index	-1.560	0.570	-2.740	0.010	-2.757	1.467	-1.879	0.060	-	-	-	-
Animal welfare index	1.630	0.670	2.450	0.010	1.215	0.509	2.389	0.017	-	-	-	-
Sympathy Index	-1.190	0.610	-1.950	0.050	-0.624	0.390	-1.599	0.110	-	-	-	-
Use/Non-use index	4.870	1.340	3.630	0.000	3.283	0.751	4.373	0.000	-	-	-	-
Income (logs)	-0.390	0.530	-0.740	0.460	-0.833	0.548	-1.519	0.129	-	-	-	-
Age	-0.030	0.020	-1.440	0.150	-0.048	0.022	-2.224	0.026	-	-	-	-
Sex	0.540	0.680	0.800	0.420	0.364	0.497	0.733	0.464	-	-	-	-
Programme Index	0.180	0.600	0.290	0.770	-0.318	0.419	-0.759	0.448	-	-	-	-
Constant	-0.820	4.900	-0.170	0.870	7.089	5.127	1.383	0.167	-	-	-	-
WTP												
Ethics index	-0.420	0.320	-1.290	0.200	-3.058	1.886	-1.622	0.105	-5.989	2.012	-2.977	0.003
Animal welfare index	1.290	0.310	4.120	0.000	0.605	0.321	1.887	0.059	1.702	0.400	4.251	0.000
Sympathy Index	-1.040	0.370	-2.840	0.010	-1.046	0.326	-3.203	0.001	-1.362	0.393	-3.465	0.001
Use/Non-use index	0.750	0.230	3.340	0.000	0.328	0.211	1.557	0.119	1.596	0.258	6.175	0.000
Income (logs)	2.200	0.500	4.440	0.000	2.388	0.502	4.758	0.000	1.615	0.546	2.955	0.003
Age	0.010	0.010	0.380	0.710	0.017	0.014	1.232	0.218	0.008	0.018	0.473	0.636
Sex	0.440	0.480	0.910	0.360	0.205	0.441	0.465	0.642	1.976	0.631	3.134	0.002
Programme Index	1.050	0.350	2.990	0.000	0.954	0.323	2.954	0.003	0.926	0.390	2.376	0.018
Constant	-19.030	4.010	-4.740	0.000	-21.594	4.207	-5.133	0.000	-20.569	4.562	-4.509	0.000
Lnsigma												
Sex	-0.296	0.109	-2.712	0.007	-0.284	0.114	-2.485	0.013	-0.428	0.117	-3.671	0.000
Age	-0.006	0.003	-1.758	0.079	-0.009	0.004	-2.513	0.012	-0.008	0.004	-2.122	0.034
Constant	1.561	0.215	7.264	0.0001	1.666	0.215	7.739	0.000	2.020	0.216	9.370	0.000
ρ	0.58	0.21	2.76	0.01	-	-	-	-	-	-	-	-
θ	0.18	0.04	4.85	0.00	0.182	0.038	4.741	0.000	0.136	0.029	4.759	0.000
Log-Likelihood	-598.39992				-603.50454				-660.45478			
Wald Chi2	20.42				25.00				86.27			
Probability>chi2	0.0085				0.0030				0.00001			
N	305				305				305			

Table 4.13. Regression Results: Box-Cox double hurdle models without sample separation.

	IHS DHD				IHS DHI				IHS Tobit			
Participation	Coeff.	Std.Error	t-stat.	P-value	Coeff.	Std.Error	t-stat.	P-value	Coeff.	Std. Error	t-stat.	P-value
Ethics index	-6.424	3.220	-1.995	0.046	-3.378	2.445	-1.382	0.167	-	-	-	-
Animal welfare index	2.585	1.105	2.339	0.019	1.504	1.011	1.489	0.137	-	-	-	-
Sympathy Index	-1.977	0.978	-2.021	0.043	-0.760	0.513	-1.481	0.139	-	-	-	-
Use/Non-use index	6.392	2.308	2.769	0.006	3.721	1.429	2.604	0.009	-	-	-	-
Income (logs)	-1.827	1.029	-1.775	0.076	-1.102	0.817	-1.348	0.178	-	-	-	-
Age	-0.092	0.042	-2.189	0.029	-0.060	0.041	-1.456	0.145	-	-	-	-
Sex	-0.412	0.998	-0.412	0.680	0.453	0.651	0.696	0.487	-	-	-	-
Programme Index	-1.324	0.891	-1.487	0.137	-0.611	1.088	-0.562	0.574	-	-	-	-
Constant	18.637	10.637	1.752	0.080	10.338	9.586	1.079	0.281	-	-	-	-
WTP												
Ethics index	-1.430	0.860	-1.663	0.096	-1.595	0.992	-1.608	0.108	-2.711	0.937	-2.895	0.004
Animal welfare index	0.351	0.143	2.455	0.014	0.316	0.166	1.907	0.056	0.752	0.188	4.009	0.000
Sympathy Index	-0.564	0.140	-4.032	0.000	-0.566	0.177	-3.208	0.001	-0.657	0.183	-3.590	0.000
Use/Non-use index	0.288	0.089	3.232	0.001	0.211	0.115	1.837	0.066	0.715	0.127	5.631	0.000
Income (logs)	1.126	0.198	5.695	0.000	1.194	0.260	4.602	0.000	0.748	0.251	2.981	0.003
Age	0.005	0.006	0.785	0.432	0.008	0.007	1.041	0.298	0.003	0.008	0.424	0.671
Sex	0.223	0.211	1.056	0.291	0.118	0.223	0.530	0.596	0.831	0.285	2.917	0.004
Programme Index	0.471	0.149	3.158	0.002	0.499	0.179	2.790	0.005	0.415	0.179	2.311	0.021
Constant	-10.826	1.579	-6.857	0.000	-11.222	2.134	-5.260	0.000	-9.512	2.173	-4.378	0.000
Lnsigma												
Sex	-0.352	0.088	-3.980	0.000	-0.275	0.113	-2.435	0.015	-0.395	0.116	-3.418	0.001
Age	-0.009	0.002	-3.545	0.000	-0.009	0.004	-2.473	0.013	-0.008	0.004	-2.296	0.022
Constant	0.961	0.212	4.525	0.000	0.986	0.239	4.132	0.000	1.222	0.231	5.294	0.000
ρ	0.306	0.143	2.147	0.032	-	-	-	-	-	-	-	-
λ	0.298	0.048	6.208	0.000	0.328	0.071	4.618	0.000	0.351	0.075	4.697	0.000
Log-Likelihood	-569.07729				-574.45094				-624.85655			
Wald Chi2	13.48				19.29				58.74			
Probability>chi2	0.1422				0.0229				0.0000			
N	305				305				305			

Table 4.14. Regression Results: Untransformed double hurdle models without sample separation.

	DHD				DHI				Tobit			
Participation	Coeff.	Std.Error	t-stat.	P-value	Coeff.	Std.Error	t-stat.	P-value	Coeff.	Std. Error	t-stat.	P-value
Ethics index	-8.683	3.428	-2.533	0.011	-3.283	2.288	-1.435	0.151	-	-	-	-
Animal welfare index	3.385	1.165	2.905	0.004	1.539	0.931	1.653	0.098	-	-	-	-
Sympathy Index	-2.335	1.018	-2.294	0.022	-0.805	0.529	-1.520	0.128	-	-	-	-
Use/Non-use index	9.367	2.883	3.249	0.001	3.726	1.235	3.017	0.003	-	-	-	-
Income (logs)	-2.581	1.039	-2.485	0.013	-1.082	0.769	-1.407	0.159	-	-	-	-
Age	-0.092	0.037	-2.479	0.013	-0.057	0.035	-1.612	0.107	-	-	-	-
Sex	0.648	0.957	0.677	0.498	0.674	0.693	0.972	0.331	-	-	-	-
Programme Index	-1.344	0.813	-1.653	0.098	-0.631	0.958	-0.658	0.510	-	-	-	-
Constant	19.852	8.488	2.339	0.019	9.983	8.639	1.156	0.248	-	-	-	-
WTP												
Ethics index	-3.969	3.106	-1.278	0.201	-4.686	3.496	-1.340	0.180	-8.235	2.792	-2.949	0.003
Animal welfare index	1.030	0.570	1.808	0.071	0.616	0.597	1.032	0.302	2.369	0.626	3.787	0.000
Sympathy Index	-1.312	0.554	-2.370	0.018	-1.318	0.578	-2.281	0.023	-1.779	0.609	-2.920	0.004
Use/Non-use index	0.975	0.349	2.794	0.005	0.456	0.411	1.108	0.268	2.465	0.375	6.582	0.000
Income (logs)	4.228	0.775	5.453	0.000	4.754	0.797	5.969	0.000	2.838	0.826	3.435	0.001
Age	0.021	0.024	0.902	0.367	0.036	0.025	1.463	0.144	0.008	0.027	0.299	0.765
Sex	0.500	0.725	0.690	0.490	-0.079	0.743	-0.107	0.915	1.684	0.811	2.077	0.038
Programme Index	1.405	0.547	2.570	0.010	1.471	0.579	2.541	0.011	0.937	0.603	1.552	0.121
Constant	-39.813	6.036	-6.596	0.000	-42.989	6.117	-7.028	0.000	-32.867	6.372	-5.158	0.000
Lnsigma	1.661	0.054	30.949	0.000	1.637	0.057	28.904	0.000	1.819	0.054	33.828	0.000
ρ	0.738	0.017	44.122	0.000	-	-	-	-	-	-	-	-
Log-Likelihood	-631.69856				-635.97602				-688.04947			
Wald Chi2	12.01				21.44				117.96			
Probability>chi2	0.2125				0.0108				0.0000			
N	305				305				305			

Table 4.15. Regression Results: Dominance models with and without sample separation

	First Hurdle Dominance without sample separation (participation and payment decisions)				First Hurdle Dominance with sample separation (reporting and payment decisions)				First Hurdle Dominance with sample separation (participation and payment decisions; no reporting decisions)			
Participation/ reporting	Coeff.	Std.Error	t-stat.	P-value	Coeff.	Std.Error	t-stat.	P-value	Coeff.	Std.Error	t-stat.	P-value
Ethics index	-1.175	0.522	-2.250	0.024	-1.725	0.616	-2.800	0.005	0.164	0.442	0.371	0.710
Animal welfare index	0.543	0.137	3.958	0.000	0.584	0.182	3.216	0.001	0.410	0.151	2.718	0.007
Sympathy Index	-0.313	0.132	-2.375	0.018	-0.613	0.158	-3.872	0.000	0.476	0.179	2.660	0.008
Use/Non-use index	0.692	0.096	7.212	0.000	0.830	0.134	6.193	0.000	0.409	0.099	4.138	0.000
Income (logs)	0.262	0.183	1.426	0.154	0.358	0.223	1.605	0.108	0.032	0.209	0.151	0.880
Age	0.007	0.006	1.149	0.250	-0.004	0.007	-0.529	0.597	0.015	0.007	2.086	0.037
Sex	0.511	0.191	2.681	0.007	0.637	0.231	2.755	0.006	0.180	0.234	0.770	0.442
Programme Index	-0.081	0.144	-0.560	0.575	-0.269	0.180	-1.492	0.136	0.004	0.169	0.023	0.982
Constant	-3.826	1.463	-2.616	0.009	-2.824	1.775	-1.591	0.112	-1.141	1.605	-0.711	0.477
WTP												
Ethics index	-4.204	3.288	-1.279	0.201	-4.220	3.286	-1.284	0.199	-3.215	1.335	-2.407	0.016
Animal welfare index	0.552	0.603	0.916	0.360	0.537	0.589	0.911	0.362	1.055	0.472	2.235	0.025
Sympathy Index	-1.487	0.555	-2.677	0.007	-1.515	0.565	-2.683	0.007	-1.466	0.444	-3.303	0.001
Use/Non-use index	0.208	0.393	0.529	0.597	0.185	0.366	0.504	0.614	1.082	0.289	3.738	0.000
Income (logs)	3.965	0.753	5.266	0.000	3.965	0.752	5.272	0.000	2.337	0.595	3.927	0.000
Age	-0.005	0.023	-0.201	0.841	-0.006	0.023	-0.271	0.787	0.001	0.020	0.066	0.947
Sex	-0.519	0.694	-0.748	0.455	-0.528	0.687	-0.769	0.442	0.714	0.605	1.180	0.238
Programme Index	1.827	0.511	3.577	0.000	1.818	0.512	3.552	0.000	1.132	0.447	2.533	0.011
Constant	-33.257	6.004	-5.539	0.000	-32.940	5.833	-5.647	0.000	-22.624	4.640	-4.875	0.000
Lnsigma	1.517	0.051	29.560	0.000	1.517	0.051	29.664	0.000	1.544	0.043	35.681	0.000
ρ	0.095	0.191	0.497	0.619	0.093	0.167	0.558	0.577	0.032	0.176	0.183	0.855
Log-Likelihood	-694.57079				-651.85029				-881.52751			
Wald Chi2	91.05				75.21				36.20			
Probability>chi2	0.00001				0.00001							
N for articipation/reporting equations	305				267				305			
N for WTP equation	192				192				192			

Table 4.16. Regression Results: IHS double hurdle models with sample separation.

	Participation and IHS DHD				Participation and IHS DHI				Participation and IHS Tobit			
Participation *(N=305)*	Coeff.	Std.Error	t-stat.	P-value	Coeff.	Std.Error	t-stat.	P-value	Coeff.	Std. Error	t-stat.	P-value
Ethics index	0.165	0.442	0.374	0.708	0.165	0.442	0.374	0.708	0.165	0.442	0.374	0.708
Animal welfare index	0.409	0.151	2.716	0.007	0.409	0.151	2.716	0.007	0.409	0.151	2.716	0.007
Sympathy Index	0.475	0.178	2.661	0.008	0.475	0.178	2.661	0.008	0.475	0.178	2.661	0.008
Use/Non-use index	0.408	0.099	4.136	0.000	0.408	0.099	4.136	0.000	0.408	0.099	4.136	0.000
Income (logs)	0.030	0.209	0.145	0.885	0.030	0.209	0.145	0.885	0.030	0.209	0.145	0.885
Age	0.015	0.007	2.087	0.037	0.015	0.007	2.087	0.037	0.015	0.007	2.087	0.037
Sex	0.176	0.233	0.757	0.449	0.176	0.233	0.757	0.449	0.176	0.233	0.757	0.449
Programme Index	-0.001	0.166	-0.007	0.995	-0.001	0.166	-0.007	0.995	-0.001	0.166	-0.007	0.995
Constant	-1.110	1.592	-0.697	0.486	-1.110	1.592	-0.697	0.486	-1.110	1.592	-0.697	0.486
Reporting *(N=267)*	Coeff.	Std.Error	t-stat.	P-value	Coeff.	Std.Error	t-stat.	P-value	Coeff.	Std. Error	t-stat.	P-value
Ethics index	-5.602	2.319	-2.416	0.016	-4.343	2.289	-1.897	0.058	-	-	-	-
Animal welfare index	2.402	0.934	2.572	0.010	1.790	0.934	1.915	0.055	-	-	-	-
Sympathy Index	-1.959	0.812	-2.412	0.016	-1.223	0.598	-2.046	0.041	-	-	-	-
Use/Non-use index	5.140	1.460	3.520	0.000	3.783	1.364	2.774	0.006	-	-	-	-
Income (logs)	-1.156	0.869	-1.331	0.183	-1.109	0.697	-1.592	0.111	-	-	-	-
Age	-0.060	0.030	-2.016	0.044	-0.069	0.039	-1.759	0.079	-	-	-	-
Sex	0.559	0.706	0.792	0.429	0.621	0.735	0.845	0.398	-	-	-	-
Programme Index	-0.688	0.741	-0.929	0.353	-0.769	0.858	-0.896	0.370	-	-	-	-
Constant	10.694	8.869	1.206	0.228	11.453	7.733	1.481	0.139	-	-	-	-
WTP												
Ethics index	-3.220	1.510	-2.132	0.033	-3.284	1.588	-2.068	0.039	-6.233	1.782	-3.497	0.000
Animal welfare index	0.515	0.294	1.750	0.080	0.377	0.278	1.355	0.175	1.305	0.361	3.620	0.000
Sympathy Index	-1.171	0.294	-3.980	0.000	-1.102	0.315	-3.503	0.000	-1.642	0.362	-4.532	0.000
Use/Non-use index	0.371	0.187	1.989	0.047	0.228	0.173	1.318	0.188	1.175	0.229	5.121	0.000
Income (logs)	1.920	0.432	4.448	0.000	1.918	0.437	4.386	0.000	1.487	0.490	3.034	0.002
Age	-0.004	0.013	-0.291	0.771	0.000	0.012	-0.027	0.978	-0.012	0.016	-0.743	0.457
Sex	0.287	0.369	0.777	0.437	0.149	0.358	0.417	0.677	1.468	0.526	2.789	0.005
Programme Index	0.894	0.292	3.065	0.002	0.943	0.302	3.126	0.002	0.898	0.350	2.566	0.010
Constant	-16.200	3.591	-4.511	0.000	-15.935	3.633	-4.387	0.000	-15.907	4.087	-3.893	0.000
Lnsigma												
Sex	-0.279	0.106	-2.640	0.008	-0.270	0.112	-2.417	0.016	-0.413	0.116	-3.571	0.000
Age	-0.008	0.003	-2.154	0.031	-0.010	0.004	-2.960	0.003	-0.009	0.004	-2.305	0.021
Constant	1.428	0.229	6.229	0.000	1.541	0.235	6.546	0.000	1.894	0.225	8.400	0.000
ρ	0.434	0.189	2.303	0.021	-	-	-	-	-	-	-	
θ	0.229	0.049	4.694	0.000	0.240	0.056	4.296	0.000	0.169	0.035	4.883	0.000
Log-Likelihood of participation decision.	-90.388612				-90.388612				-90.388612			
Log-Likelihood of hurdle model	-567.85203				-571.35188				-625.14363			
Wald Chi2	13.93				13.88				73.71			
Probability>chi2	0.1248				0.1266				0.00001			
N	267				267				267			

Table 4.17. Expected Unconditional WTP Values (in US$)

	Without sample separation		With sample separation	
	E(WTP)	Std. Dev	E(WTP)	Std. Dev
IHSDHD	5.52	3.03	5.42	2.97
IHSDHI	5.75	2.98	5.62	2.90
IHSTOBIT	4.02	1.48	4.92	1.35
BCDHD	6.69	3.73	6.42	3.67
BCDHI	6.45	6.12	6.62	3.60
BCTOBIT	5.29	6.32	5.92	2.05
DHD	4.04	2.91	4.43	3.18
DHI	4.07	1.71	4.15	2.96
TOBIT	3.07	1.62	3.88	1.51

Table 4.18. Income Elasticity of WTP

	Without sample separation		With sample separation	
	Income Elasticity of WTP	t-stat.	Income Elasticity of WTP	t-stat.
IHSDHD	0.31	2.91	0.33	4.01
IHSDHI	0.29	2.01	0.31	3.06
IHSTOBIT	0.37	3.60	0.40	2.60
BCDHD	0.34	4.57	0.36	3.87
BCDHI	0.31	4.52	0.33	3.29
BCTOBIT	0.37	4.76	0.40	4.19
DHD	0.48	1.74	0.51	1.97
DHI	0.69	2.99	0.74	2.97
TOBIT	0.86	4.45	0.92	2.00

Note: Asymptotic Standard errors for the t-statistic calculated with the Delta method.

Table 4.19. Average Probabilities of IHSDHD model without sample separation

	Probability
Probability of abstention	.26
Probability of a corner solutions	.12
Total probability of zero response	.38

Table 4.20. Average Probabilities: Trivariate Model

	Probability
Full sample:	
Probability of abstention	.13
Potential and current demanders:	
Probability of corner solutions	.13
Probability of misreporting	.17
Total probability of reporting zero for individuals in the market	.30

4.16.Appendix 3. Likelihood functions, E(WTP), and Marginal Effects

Likelihood Functions.

$$\ln L_{IHSDHD} = \sum_{0}\left[1-\Phi\left(\alpha' Z_i, \beta' X_i / \sigma_\varepsilon, \rho_{\varepsilon,\nu}\right)\right]$$

$$\sum_{+}\left\{-\frac{1}{2}\cdot\ln(1+\theta^2\cdot y^2)-\ln\sigma_\varepsilon-\ln\left(\sqrt{2\pi}\right)-\frac{1}{2}\left[\frac{y_i(\theta)-\beta' X_i}{\sigma_\varepsilon}\right]^2+\right.$$

$$\left.\ln\Phi\left[\frac{\alpha' Z_i+\rho_{\varepsilon,\nu}\cdot\left(\dfrac{y_i(\theta)-\beta' X_i}{\sigma_\varepsilon}\right)}{(1-\rho^2_{\varepsilon,\nu})^{1/2}}\right]\right\}$$

$$\ln L_{IHSDHI} = \sum_{0} 1-\Phi\left(\alpha' Z_i\right)\cdot\Phi\left(\beta' X_i / \sigma_\varepsilon\right)$$

$$\sum_{+} -\frac{1}{2}\ln(1+\theta^2\cdot y^2)-\ln\sigma_\varepsilon-\ln\left(\sqrt{2\pi}\right)-\frac{1}{2}\left[\frac{y_i(\theta)-\beta' X_i}{\sigma_\varepsilon}\right]^2+\Phi(\alpha' Z_i)$$

$$L_{BCDHD} = \prod_{+}\left[1-\Phi\left(\alpha' Z_i, \frac{(\beta' X_i + 1/\lambda)}{\sigma_\varepsilon}, \rho_{\varepsilon,\nu}\right)\right]\times$$

$$\prod_{+}\left\{\frac{y^{\lambda-1}\cdot\dfrac{1}{\sigma_\varepsilon}\cdot f\left(\dfrac{\dfrac{y_i^\lambda-1}{\lambda}-\beta' X}{\sigma_\varepsilon}\right)\cdot\Phi\left[\dfrac{\alpha' Z_i+\dfrac{\rho_{\varepsilon,\nu}}{\sigma_\varepsilon}\cdot\left(\dfrac{y_i^\lambda-1}{\lambda}-\beta' X\right)}{\sqrt{1-\rho^2_{\varepsilon,\nu}}}\right]}{\Phi\left(\alpha' Z_i, \dfrac{(\beta' X_i+1/\lambda)}{\sigma_\varepsilon}, \rho_{\varepsilon,\nu}\right)}\right\}\times$$

$$\prod_{+}\Phi\left(\alpha' Z_i, \frac{(\beta' X_i+1/\lambda)}{\sigma_\varepsilon}, \rho_{\varepsilon,\nu}\right)$$

$$L_{BCDHI} = \prod_{0}\left[1-\Phi(\alpha' Z_i)\cdot\Phi\left[\frac{\beta' X_i+1/\lambda}{\sigma_\varepsilon}\right]\right]$$

$$\prod_{1}\left\{\Phi(\alpha' Z_i)\cdot y^{\lambda-1}\cdot\frac{1}{\sigma_\varepsilon}\cdot\phi\left(\frac{\dfrac{y_i^\lambda-1}{\lambda}-\beta' X}{\sigma_\varepsilon}\right)\right\}$$

$$L_{DHD} = \prod_0 \left[1 - \Phi(\alpha' Z_i, \frac{(\beta' X_i)}{\sigma_\varepsilon}, \rho \right]$$

$$\prod_1 \left\{ \Phi \left[\frac{\alpha' Z_i + \frac{\rho_i}{\sigma_\varepsilon}(y_i - \beta' X)}{\sqrt{1-\rho^2}} \right] \cdot \frac{1}{\sigma_\varepsilon} \cdot f\left(\frac{y_i - \beta' X}{\sigma_\varepsilon} \right) \right\}$$

$$L_{DHI} = \prod_0 [1 - \Phi(\alpha' Z_i) \cdot \Phi(\beta' X_i / \sigma_\varepsilon)]$$

$$\prod_1 \left\{ \Phi(\alpha' Z_i) \cdot \frac{1}{\sigma_\varepsilon} \cdot \phi\left(\frac{y_i - \beta' X}{\sigma_\varepsilon} \right) \right\}$$

$$L_{Tobit} = \prod_0 \Phi(-\beta' X / \sigma_\varepsilon) \prod_+ \left\{ \frac{1}{\sigma_\varepsilon} \cdot \phi\left(\frac{y_i - \beta' X}{\sigma_\varepsilon} \right) \right\}$$

$$\ln L_{FHD} = \sum_0 \ln[\Phi(-\alpha' Z_i)] +$$

$$\sum_+ \left\{ -\ln \sigma_\varepsilon + \ln \Phi\left(\frac{\alpha' Z_i + \frac{\rho}{\sigma_\varepsilon}(y_i - \beta' X)}{\sqrt{1-\rho^2}} \right) + \ln f\left(\frac{y_i - \beta' X}{\sigma_\varepsilon} \right) \right\}$$

$$\ln L_{CD} = -\frac{n_1}{2} \ln \sigma^2 + \sum_+ \ln \varphi[(y_i - \beta' X_i / \sigma) +$$

$$+ \sum_+ \ln \Phi(\alpha' Z) + \sum_0 \ln[1 - \Phi(\alpha' Z_i)]$$

Expected WTP

Expected unconditional WTP for all LDV models is given by

$$E(y) = P(y > 0) \cdot E(y / y > 0)$$

This expression for the BCDHD model is:

$$E(y_i) = \int_0^{\infty} y^{\lambda} \cdot \frac{1}{\sigma_{\varepsilon}} \cdot f\left(\frac{\frac{y_i^{\lambda} - 1}{\lambda} - \beta' X}{\sigma_{\varepsilon}} \right) \cdot \Phi\left[\frac{\alpha' Z_i + \frac{\rho_{\varepsilon,\nu}}{\sigma_{\varepsilon}} \cdot (\frac{y_i^{\lambda} - 1}{\lambda} - \beta' X)}{\sqrt{1 - \rho_{\varepsilon,\nu}^2}} \right] dx$$

while for the IHSDHD it is:

$$E(y_i) = \int_0^{\infty} y_i \cdot (1 + \theta^2 \cdot y_i^2)^{-1/2} \times \frac{1}{\sigma_{\varepsilon}} \cdot \phi\left[\frac{I(y_{ii}, \theta) - \beta' X_i}{\sigma_{\varepsilon}} \right] \Phi\left[\frac{\alpha' Z_i + \rho_{\varepsilon,\nu} \cdot \left(\frac{I(y_{ii}, \theta) - \beta' X_i}{\sigma_{\varepsilon}} \right)}{\sqrt{1 - \rho_{\varepsilon,\nu}^2}} \right]$$

The expected value of the latent variable y^* is given simply by

$E(y^*) = \beta' X$ for the models linear in y^* . For the transformed models the expected value of the latent variable is given by:

$$I(y, \theta) = \sinh^{-1}(\theta \cdot y) = \beta x \cdot \theta \Rightarrow \theta \cdot y = \sinh(\theta \cdot y) \Rightarrow y = \frac{\sinh(\beta x \cdot \theta)}{\theta} \Rightarrow$$

$$y = \left(\frac{e^{(\theta \cdot \beta x)} - e^{(-\theta \cdot \beta x)}}{2} \right) / \theta$$

for the IHS model while for the Box-Cox model it is given by:

$$y^{*}_{(\lambda)} = \frac{y^{\lambda} - 1}{\lambda} = \beta' X \Rightarrow y^{\lambda} - 1 = \beta' X \cdot \lambda \Rightarrow y^{\lambda} = \beta' X \cdot \lambda + 1 \Rightarrow y = [\beta' X \cdot \lambda + 1]^{1/\lambda}$$

Marginal effects

The marginal effects of the BCDHD model are given by

$$\frac{\partial E(y_i^*)}{\partial x_i} = \int_0^\infty y^{\lambda-1} \frac{\partial h(\cdot)}{\partial x_i} dy_i$$

where

$$\frac{\partial h(\cdot)}{\partial x_i} = \Phi\left[\frac{\alpha' Z_i + \frac{\rho_{\varepsilon,\nu}}{\sigma_\varepsilon}\cdot(\frac{y_i^\lambda - 1}{\lambda} - \beta' X)}{\sqrt{1-\rho_{\varepsilon,\nu}^2}}\right]\cdot\frac{1}{\sigma_e{}^2}\cdot f\left(\frac{\frac{y_i^\lambda - 1}{\lambda} - \beta' X}{\sigma_\varepsilon}\right)\times$$

$$\left\{\left(\frac{\frac{y_i^\lambda - 1}{\lambda} - \beta' X}{\sigma_\varepsilon}\right)\cdot\beta_i + \left[\left(\frac{\frac{y_i^\lambda - 1}{\lambda} - \beta' X}{\sigma_\varepsilon}\right)^2 - 1\right]\cdot\left(\frac{\partial\sigma_e}{\partial x_i}\right)\right\} +$$

$$\frac{1}{\sigma_\varepsilon}\cdot f\left(\frac{\frac{y_i^\lambda - 1}{\lambda} - \beta' X}{\sigma_\varepsilon}\right)\cdot\Phi\left[\frac{\alpha' Z_i + \frac{\rho_{\varepsilon,\nu}}{\sigma_\varepsilon}\cdot(\frac{y_i^\lambda - 1}{\lambda} - \beta' X)}{\sqrt{1-\rho_{\varepsilon,\nu}^2}}\right]\times$$

$$\left\{\frac{\alpha_i - \frac{\rho_{\varepsilon,\nu}}{\sigma_\varepsilon}\left[\beta_i + 2\left(\frac{\frac{y_i^\lambda - 1}{\lambda} - \beta' X}{\sigma_\varepsilon}\right)\left(\frac{\partial\sigma_e}{\partial x_i}\right)\right]}{\sqrt{1-\rho_{\varepsilon,\nu}^2}} - \left(\frac{\rho_{\varepsilon,\nu}^2}{1-\rho_{\varepsilon,\nu}^2}\right)\cdot\left[\frac{\alpha' Z_i + \frac{\rho_{\varepsilon,\nu}}{\sigma_\varepsilon}\cdot(\frac{y_i^\lambda - 1}{\lambda} - \beta' X)}{\sqrt{1-\rho_{\varepsilon,\nu}^2}}\right]\cdot\left(\frac{1}{\sigma_\varepsilon}\right)\cdot\left(\frac{\partial\sigma_e}{\partial x_i}\right)\right\}$$

and

$$\frac{\partial\left[\Phi\left(\alpha' Z_i, \frac{(\beta' X_i + 1/\lambda)}{\sigma_\varepsilon}, \rho_{\varepsilon,\nu}\right)\right]}{\partial x_i} = f(\beta' X_i)\cdot\Phi\left[\frac{\frac{\beta' X + 1/\lambda}{\sigma_\varepsilon} - \rho_{\varepsilon,\nu}\cdot\alpha' Z_i}{\sqrt{1-\rho_{\varepsilon,\nu}^2}}\right]\cdot\alpha_i + \frac{1}{\sigma} f\left(\frac{\beta' X + 1/\lambda}{\sigma_\varepsilon}\right)\times$$

$$\Phi\left[\frac{\alpha' Z_i - \frac{\rho_{\varepsilon,\nu}}{\sigma_\varepsilon}\cdot(\beta' X + 1/\lambda)}{\sqrt{1-\rho_{\varepsilon,\nu}^2}}\right]\cdot\left[\beta_i - \left(\frac{(\beta' X_i + 1/\lambda)}{\sigma_\varepsilon}\right)\left(\frac{\partial\sigma_e}{\partial x_i}\right)\right] -$$

$$f\left[\frac{\alpha' Z_i - \frac{\rho_{\varepsilon,\nu}}{\sigma_\varepsilon}\cdot(\beta' X + 1/\lambda)}{\sqrt{1-\rho_{\varepsilon,\nu}^2}}\right]\left(\frac{\rho_{\varepsilon,\nu}}{\sigma_\varepsilon}\right)\left(\frac{\partial\sigma_e}{\partial x_i}\right)$$

Marginal effects for the IHS models have to be derived through numerical integration and differentiation while asymptotic standard errors can be obtained via the Delta method.

4.17 Appendix 3: STATA Programme Codes of Maximum Likelihood Estimation of likelihood Functions.

Inverse Hyperbolic Sine Double Hurdle Dependent

```
program define myihsd
version 6
args lnf theta1 theta2 theta3 theta4 theta5
tempvar R Q J
    quietly gen double `R' = 0.5 * ln((1+`theta4')/(1-`theta4'))
     quietly gen double `J'=(`theta5'^2*$ML_y2^2+1)
    quietly gen double `Q'=ln(`theta5'*$ML_y2 +(`J')^0.5)/(`theta5')
    quietly replace `lnf'=ln(binorm(-`theta1',-`theta2'/exp(`theta3'),`R') + binorm(-`theta1',`theta2'/exp(`theta3'),-
`R')+binorm(`theta1',-`theta2'/exp(`theta3'),-`R')) if $ML_y1==0
    quietly replace `lnf'=-0.5*ln(`J')-ln(2.506628275)-(`theta3')-0.5*(`Q'-
`theta2')^2/exp(`theta3')^2+ln(normprob((`theta1'+`R'/`theta3'*(`Q'-`theta2'))/sqrt(1-`R'^2))) if $ML_y1==1
end
```

Inverse Hyperbolic Sine Double Hurdle Independent

```
program define myihsi
version 6
  args lnf theta1 theta2 theta3 theta4
  tempvar Q J
  quietly gen double `J'=(`theta4'^2*$ML_y2^2+1)
  quietly gen double `Q'=ln(`theta4'*$ML_y2 +(`J')^0.5)/(`theta4')
  quietly replace `lnf'=ln(1-(normprob((`theta1'))*normprob((`theta2')/exp(`theta3')))) if $ML_y1==0
  quietly replace `lnf'=-0.5*ln(`J')-ln(2.506628275)-(`theta3')-0.5*(`Q'-
`theta2')^2/exp(`theta3')^2+ln(normprob(`theta1')) if $ML_y1==1
end
```

Inverse Hyperbolic Sine Tobit

```
program define myihst
version 6
  args lnf theta1 theta2 theta3
  tempvar Q J
  quietly gen double `J'=(`theta3'^2*$ML_y1^2+1)
  quietly gen double `Q'=ln(`theta3'*$ML_y1 +(`J')^0.5)/(`theta3')
  quietly replace `lnf'=ln(1-normprob((`theta1')/exp(`theta2'))) if $ML_y1==0
  quietly replace `lnf'=-0.5*ln(`J')-ln(2.506628275)-(`theta2')-0.5*(`Q'-`theta1')^2/exp(`theta2')^2 if $ML_y1>0
end
```

Box-Cox Double Hurdle Dependent

```
program define mybcdhd
version 6
args lnf theta1 theta2 theta3 theta4 theta5
tempvar R
    quietly gen double `R'= 0.5 * ln((1+`theta4')/(1-`theta4'))
    quietly replace `lnf'=ln(binorm(-`theta1',-`theta2'/exp(`theta3'),`R') + binorm(-`theta1',`theta2'/exp(`theta3'),-
`R')+binorm(`theta1',-`theta2'/exp(`theta3'),-`R'))  if $ML_y1==0
    quietly replace `lnf'=(-ln(2.506628275)-(`theta3')-0.5*((($ML_y2^`theta5'-1)/`theta5')-
`theta2')^2/exp(`theta3')^2+(`theta5'-1)*ln($ML_y2)+ln(normprob((`theta1'+`R'/`theta3'*(($ML_y2^`theta5'-
1)/`theta5'-`theta2'))/sqrt(1-
`R'^2))))*(1/(binorm(`theta1',`theta2'/exp(`theta3'),`R')))*(binorm(`theta1',`theta2'/exp(`theta3'),`R'))  if
$ML_y1==1
end
```

Box-Cox Double Hurdle Independent

```
program define mybcdhi
version 6
  args lnf theta1 theta2 theta3 theta4
  quietly replace `lnf'=ln(1-(normprob((`theta1'))*normprob((`theta2')/exp(`theta3')))) if $ML_y1==0
  quietly replace `lnf'=-ln(2.506628275)-(`theta3')-1/2*((($ML_y2^`theta4'-1)/`theta4'-
`theta2')^2/exp(`theta3')^2)+ln(normprob(`theta1'))+ (`theta4'-1)*(ln($ML_y2)) if $ML_y1==1
end
```

Box-Cox Tobit

```
program define mybctob
version 6
args lnf theta1 theta2 theta3
quietly replace `lnf'=ln(normprob((-`theta1')/exp(`theta2'))) if $ML_y1==0
quietly replace `lnf'=-ln(2.506628275)-(`theta2')-1/2*((($ML_y1^`theta3'-1)/`theta3'-
`theta1')^2/exp(`theta2')^2)+(`theta3'-1)*(ln($ML_y1)) if $ML_y1>0
end
```

Double Hurdle Dependent

```
program define mydhd
version 6
  args lnf theta1 theta2 theta3 theta4
  tempvar R
  quietly gen double `R'= 0.5 * ln((1+`theta4')/(1-`theta4'))
  quietly replace `lnf'=ln(binorm(-`theta1',-`theta2'/exp(`theta3'),`R') + binorm(-`theta1',`theta2'/exp(`theta3'),-
`R')+binorm(`theta1',-`theta2'/exp(`theta3'),-`R')) if $ML_y1==0
  quietly replace `lnf'=(-ln(2.506628275)-(`theta3')-0.5*($ML_y2-
`theta2')^2/exp(`theta3')^2+ln(normprob(`theta1'+(`R'/exp(`theta3'))*($ML_y2-`theta2')/sqrt(1-
`R'^2))))*(1/(binorm(`theta1',`theta2'/exp(`theta3'),`R')))*(binorm(`theta1',`theta2'/exp(`theta3'),`R')) if
$ML_y1==1
end
```

Double Hurdle Independent

```
program define mydhi
version 6
  args lnf theta1 theta2 theta3
  quietly replace `lnf'=ln(1-(normprob((`theta1'))*normprob((`theta2')/exp(`theta3')))) if $ML_y1==0
  quietly replace `lnf'=-ln(2.506628275)-(`theta3')-1/2*($ML_y2-
`theta2')^2/exp(`theta3')^2+ln(normprob(`theta1')) if $ML_y1==1
end
```

Tobit

```
program define mytob
version 6
  args lnf theta1 theta2
  quietly replace `lnf'=ln(normprob((-`theta1')/exp(`theta2'))) if $ML_y1==0
  quietly replace `lnf'=-ln(2.506628275)-(`theta2')-0.5*($ML_y1-`theta1')^2/exp(`theta2')^2 if $ML_y1>0
end
```

PART B: POLICY AND LEGAL EXPLORATIONS

CHAPTER FIVE

WTP for Wildlife Conservation and the *Ex-situ* vs. *In Situ* Debate

CHAPTER FIVE

WTP for Wildlife Conservation and the *Ex-situ* vs. *In Situ* Debate

5.1. Introduction - Motivation of the study

This chapter moves away from exploring contemporary technical and methodological aspects concerning the design and analysis of stated preference non-market valuation methods and presents the results from a contingent valuation study which examined the magnitude and nature of values for the conservation of one highly celebrated species, the Giant Panda. The study was motivated from observing a paradox in many current wildlife conservation policies. On the one hand we can observe the predominance of the flagship species phenomenon as a means for raising support for general biodiversity conservation and on the other we can discern an increasing reliance on *ex situ* wildlife conservation policies that do *not* contribute to habitat conservation. The CV study presented here attempts to address some issues in relation to this paradox.

It can be readily observed that there are quite a few examples of species that have dramatically greater appeal to humans than do others. These are those species that are immediately identifiable by name (e.g. elephant, lion, rhino, tiger, panda) and often have some charismatic or symbolic attributes.[1] The values for such species has been exhibited both by revealed (e.g. donations to conservation organisations) and stated preference data (see Loomis and White 1996). Further, it has been widely accepted that the bulk of these values consist of so called existence values. These values stem from various motivations and take the form of animal welfare value as well as the value for preserving the naturalness or habitat of the species. In

[1] Meta-analyses of the WTP for individual species have found that there is a significant preference for a few charismatic species relative to the vast bulk of less noted or notable ones, and that this preference is rooted in a wide range of psychological and cultural factors (Loomis and Giraud, 1997; Kontoleon, 1996; Loomis and White, 1996; Metick and Weitzman, 1996).

either case what differentiates existence from other forms of value is that the former are independent from any form of human use (Pearce and Turner, 1990).

Because of this association between the species and their naturalness or habitats, these charismatic species are also sometimes referred to as "flagship" species. As a result, such flagship species have often been used as representatives of the general problem of endangered species and biodiversity. For example, conservation NGOs often focus their appeals for funding around the plight of a particular charismatic species, as in "adopt an elephant" appeals. The World Wide Fund for Nature (WWF) even uses the Giant Panda as the emblem of its general campaign for the conservation of natural systems.[2] So, these species are not just highly valued for themselves, but also highly valued in their representative status.[3]

However, whilst we observe strong societal preferences for preserving certain charismatic species and their habitats, we also observe the paradox that some of these species are themselves being subjected to *ex situ* conservation efforts. These usually consist of artificial breeding centres with little possibility of reintroduction into natural habitat (Olney *et al*, 1995). Some notable examples include the tiger (Meacham, 1997) and the Giant Panda (Swanson and Kontoleon, 2000). Closer examination of many current conservation polices suggest that for a non-trivial number of species the preservation of their stock levels no longer requires habitat conservation. This entails that in many cases *ex situ* and *in situ* policies are not complementary but separate and even competing approaches to conservation. Being separate polices they entail different paths for conservation as well as different costs and benefits and policy trade-offs. The welfare implications of this new policy dimension deserve further investigation. For example, why would (global) society choose to preserve *in situ* instead of *ex situ* wildlife stocks? On what basis would it be justified to allocate additional resources to the conservation of a species beyond those required for the *ex situ* preservation of

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[2] For example this focus on charismatic species is the explicit and primary strategy of the WWF: "The WWF global network focuses particular attention on a small number of globally important 'flagship' species: the giant panda, tiger, marine turtles, great apes, whales, elephants (African and Asian) and rhinos (in both Africa and Asia)." The WWF even has explicitly chosen 10 species to base its entire fund raising campaign. These are the Chimpanzee, Elephant, Giant panda, Golden lion, Mountain gorilla, North Atlantic Whale, Orang-utan, Rhino, Snow leopard, and Tiger.

[3] See Leader Williams and Dublin (2000), Williams *et al.* (2000a) and (2000b) for a discussion of the flagship species phenomenon.

its stock? Are agencies that utilise appropriated existence values for *ex situ* wildlife conservation practices efficiently allocating (conservation) resources? What is the role of existence value in the face of this new policy dimension of *ex situ* wildlife conservation?

This policy framework motivated a contingent valuation study that examined the values for preserving one particular charismatic species, the Giant Panda. The case of the Panda is particularly relevant to the questions raised above since it itself exhibits an interesting and two-pronged paradox. Firstly, the species is highly endangered by reason of habitat disruption, despite being one of the most widely recognisable and cherished species in the world. Secondly, despite being such a prominent flagship species, the conservation efforts being contemplated for its survival do not include habitat conservation but rely increasingly on captive breeding programmes in *ex situ* facilities.

The CV study considered three issues in particular detail. The first part of this study investigates the WTP for panda lands provided for the sole purpose of panda conservation. As will be described in more detail below, there are at present only about one thousand pandas remaining in their natural habitat in Sichuan province, China. Would society be willing to purchase the property rights to the remaining panda habitat to conserve this species? This is an important policy question considering that we observe a clear shift towards *ex situ* Panda conservation practices. We find that a significant and theoretically consistent WTP for such land exists.

The second part of our study examines the nature of this flagship-inspired demand for habitat. In the spirit of Loomis and White (1996), we view the demand for panda habitat as a possible form of derived demand for general biodiversity conservation.

> "[The valuation of a well-known species] may often include implicit valuation for the components of the ecosystem that supports these high-profile species. For example, humans may value watching bald eagles yet be unaware or indifferent towards pocket gophers. Yet, if pocket gophers are a critical part of the raptors' food supply, then humans have a derived value for the pocket gophers and their habitat."(Loomis and White 1996, 198).

In order to assess the nature of this derived demand, we decompose the WTP for the conservation of the giant panda into two components: 1) its quantitative component (the WTP for preserving the stock levels of the species); and 2) its qualitative component (the WTP for the quality of environment in which the species resides). We determine the relative proportion of the value of panda habitat that is attributable to these quantitative and qualitative components. We further examine this qualitative component of the WTP for panda habitat. We investigate the extent to which there is a value flowing from the "naturalness" of the habitat, and the extent to which it is a logically distinct entity from the other values. We find that there is an important, substantial and distinct value attaching to the conservation of the panda within its natural habitat. This provides support for the view that the flagship approach to conservation may be able to provide funding for broader aspects of nature conservation other than the mere preservation of the flagship species itself.

Finally, we investigate the ability of respondents to separate the value of "panda habitat" from the value of the panda. That is, to what extent is the flagship species a necessary instrument for the conservation of its habitat. We find that there is some evidence to support the proposition that the WTP for the panda habitat drops to zero, if the conservation of the panda is not guaranteed.

The particular case study provides a contribution to CV literature that has examined wildlife values. Yet, the motivation for undertaking the study as well as the issues it addresses significantly differ from other wildlife CV studies. Most CV studies that have explored values for wildlife conservation have considered policy scenarios where conservation concerned *in situ* wildlife stocks. All other dimensions of conservation, such as quality dimensions, have been held constant. As a result past CV studies have relied on a uni-dimensional conception of 'total' economic wildlife value that models all component values, such as use and existence values, solely as a function of stock size (e.g. Fredman, 1995). This conception of value was sufficient to construct credible and relevant CV conservation scenarios that could assess the WTP for the preservation of a specific stock size. Yet, as mentioned above, we can observe that in many cases wildlife stock preservation no longer requires habitat conservation. Hence, it appears that current wildlife conservation involves a new policy dimension, that of the 'means' or 'quality' of conservation. The current study differs from other CV wildlife studies in that it is based on a multidimensional conception of value that allows for different component values to be a function of different dimensions of wildlife conservation. More specifically, the study is based on the premise that use values for remote species (mainly genetic information values) are a function of stock size whereas existence values (comprising of animal welfare and implicit biodiversity values) are dependent upon qualitative aspects of wildlife conservation. Moreover, we employ an alternative approach to decomposing total economic values which seems to be less demanding to respondents than that followed in other previous decomposition studies

The next section substantiates the claim made that for a nontrivial number of charismatic species *ex situ* policies are increasingly substituting *in situ* wildlife conservation programmes. Section 5.3 discusses a multidimensional conception of wildlife value that is more relevant in the face of current wildlife conservation policies. The section also describes how wildlife values can be decomposed into component values. Section 5.4 describes the Panda paradox in more detail and why this species was chosen to address the questions raised above. Section 5.5 describes the details of the CV study. Sections 5.6 to 5.13 present the results of the study along with the results from internal validity checks. Lastly, Section 5.14 presents some concluding remarks on the *ex situ* vs. *in situ* debate as well as on the use of charismatic species as instruments for biodiversity conservation.

5.2. Wildlife conservation the *in situ* Vs. *ex situ* debate

As acknowledged in the introduction most wildlife conservation strategies focus on preserving a few flagship-species with the general aim often being the conservation of habitat and the biodiversity that lies within. This is a 'species' approach to biodiversity conservation as opposed to an 'ecosystems' approach. The strategy of the latter would choose to preserve biodiversity rich ecosystems independently of whether they contained any flag-ship species. Irrespective of the relative merits of each approach, it is clear that the flag-ship species phenomenon is as strong as ever (Metrick and Wietzman, 1996). A paradoxical aspect of many 'flag-ship' conservation plans is that they involve *ex situ* conservation policies. These refer to policies that attempt to preserve a species in an artificial/man-made environment in such a manner that a viable population is maintained.[4] The main argument in favour of *ex situ* practices is that they are complementary policies to *in situ* wildlife conservation. Yet, the realities of current *ex situ* conservation practices clearly suggest that these two types of policies are often substitutes. Since the current detachment of *ex situ* and *in situ* policies is central to the questions examined in this chapter we briefly discussed this issue in the sub-sections below.

5.2.1 *Ex situ* as complementing *in situ* conservation

Ex situ wildlife conservation policies range from captive breeding programmes to genome resource banks in which species' sperm, embryos, blood products, tissue and DNA are cryobanked. *Ex situ* facilities may be in close proximity to the original habitat of the species but could even be located in other countries. The species included in the programmes may have been breed in captivity or may have been captured from the wild. Also, the species born in captivity may have resulted from natural breeding but artificial techniques may also be used if species experience difficulties in mating in captivity or if added genetic diversity has to be introduced (on account of inbreeding problems). Finally, *ex situ* policies may or may not allow for direct species utilisation (i.e. they may be solely devoted to conservation, they may include recreational possibilities such as in zoos or may supply species bred in captivity for direct uses for the production of consumer goods and medicines).

Advances in the scientific fields contributing to the practice of captive breeding (namely in genetics, artificial insemination, and cryobiology) have brought about dramatic improvements in the birth and survival rates of captive animals.[5] This implies that *ex situ* long-term

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[4] Olney *et al.* (1994) provide a coverage of various scientific issues concerning breeding programmes while Wildt *et al.* (1997) discuss the application of genome resource banks for the *ex situ* conservation of wildlife.

[5] There is some debate as to the degree of success in birth and survival rates in captive breeding programmes. Also there is debate as to the behavioural implications on captive animals as well as over how to treat excess animals (e.g. culling, release into the wild etc.). Finally there is much debate as to the degree to which genetic diversity within the species is maintained as well as over the evolutionary path that captive wild animals are lead into. For a detailed coverage of these issues see Olney *et al.* (1994) and Norton *et al.* (1995). For the purposes of this paper, it will be accepted that captive breeding programmes can be successful in conserving the stock of any given species and that they only affect the animal welfare level of the species (and not its evolutionary path).

conservation of species is technically feasible.[6] Yet, *ex situ* policies have not been advocated on the basis of their feasibility but on the degree to which they contribute to *in situ* conservation. Supporters of *ex situ* approaches stress that the *in situ/ex situ* dichotomy is artificial and that in fact the two approaches are complementary. It is argued that *ex situ* policies should be viewed as intermediary programmes with the ultimate objective being the reintroduction of species into the wild and the replenishing of wild stocks. (Olney *et al.*, 1994; Norton *et al.*, 1995). Arguments used to justify this reasoning include:

- Policy makers are often left with no other option but to use *ex situ* policies in the short/mid term. This is a "Noah's Ark" type of reasoning in which species are to be temporarily placed in an artificial environment and then reintroduced to the wild at a later stage. Viewed in this way *ex situ* policies are merely providing the possibility or option to future generations to enjoy the benefits from *in situ* wildlife conservation (e.g. genetic resource, recreational and existence values).
- Captive breeding programmes provide a means of transferring knowledge and technological innovation from developed to developing countries in order to assists wildlife *in situ* wildlife conservation.
- *Ex situ* policies can supply stocks of certain species for which there is high consumptive demand. This would aim at alleviating poaching pressures on *in situ* stocks.
- *Ex situ* programmes in zoos can enhance public awareness and raise funding for *in situ* conservation.
- *Ex situ* programmes are more cost effective than *in situ* programmes. This releases funds for other *in situ* conservation programmes.

It is apparent that all arguments in favour of *ex situ* conservation centre around the aim of furthering *in situ* conservation. The subsections below provide a closer examination of these arguments suggests and show that the realties of wildlife conservation programmes suggest that for a non-trivial number of species *ex situ* and *in situ* policies are in fact substitute and not complementary policies.

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[6] To minimize the problems form potential inbreeding captive breeding centres and zoos have developed an elaborate computerized mating system known as the Species Survival Plan, (SSP). Hence, it is believed that it is

5.2.2 Reintroduction arguments for *ex situ* conservation programmes.

The prospect of reintroducing animals bred in captivity into the wild is considered to be the most strongest argument in favour of *ex situ* programmes since it provides the most direct link between the practice of captive breeding and replenishing wild stocks. Yet, the practice of reintroduction is a complete failure (see Balmford, 2000; Conway, 2000; Magin *et al.*, 1994; Olney *et al.* 1994; Alibhai and Jewell 1993). Most breeding programmes have not pursued re-introduction at all while in cases where it has been attempted it has had no effect on replenishing wild stocks. Moreover, any future prospects for improving the record of re-introduction rates is bleak. This is because *ex situ* programmes do not address the forces that led to the endangerment of the species in the first place. These have been shown to be associated primarily with habitat conversion and not with the inability for natural reproduction of the species (Swanson 1994s; Swanson and Barbier 1992; Barbier *et al.*, 1990). Moreover there are biological and/or behavioural reasons why reintroduction is a failed policy objective.[7] These concern difficulties that wild animals breed in captivity face when trying to adapt to *in situ* conditions (see Olney *et al.* (1994) for a review of these difficulties).

Captive breeding programmes are presented by sectors of the conservation community as modern Noah's Arks. Yet, the species got off the original Ark when it landed on Mount Ararat after having fulfilled its purpose. The realities of captive breeding programmes suggest that most species survival plans include no provision for reintroduction. In most cases reintroduction remains a pious hope or wishful thinking. For example out of a total 1150 captive breeding programmes undertaken globally only an estimated 145 have attempted to pursue some form of reintroduction project. Of these programmes an estimated 16 (or 11%)

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technically feasible to maintain in *ex situ* conditions an adequate level of genetic diversity within a particular species. Whether it will be able to reintroduce this species into the wild is much more contentious.

[7] Behavioural patterns of captive wild animal species are altered to the extent that re-introduction becomes economically and practically infeasible. A recent striking example concerns efforts to reintroduce just one individual from the killer whale species, Keiko, the five-ton star of the 'Free Willy' movies series. The specific whale been kept in captivity for about 25 years (it was captured when it was an infant). For the past two years Keiki has been kept in the harbour of Klettsvik, in the Western Islands off the coast of Iceland, where a team of scientists have been trying to reintroduce him. More than US$15million (!) has been spent and yet all attempts have failed. (Guardian, Friday March 29, 2002).

have had some moderate success in contributing to *in situ* conservation. (see **Table 5.1**). Moreover, frequently quoted *ex situ* success stories are deceptive. For example, in the often quoted Golden Lion Tamarin and the whopping crane cases public funds (i.e. non-use values) were used to acquire habitat while in the case of the Arabian oryx local people were provided financial benefits to safe guard the species against poachers (Loftin, 1994, pp. 174-175). In all cases the conservation of the species had little to do with the attempted breeding programme but must be attributed to the appropriation of values that covered the opportunity cost of land and to the provision of appropriate conservation incentives to local people.

Further, Table 5.2 presents data on the total number of threatened species (excluding aquatic species and insects) for which captive breeding has been chosen as the main conservation strategy. It can be seen that 34% of all threatened mammals and 20% of all threatened reptiles are involved in captive breeding and conservation programmes. This makes clear that policy makers have chosen to opt for *ex situ* approaches for a non-trivial number of species. What is more, scientists have made alarming (albeit varying) projections over the future rates of further habitat conversion and further additions to the IUCN threatened species lists (see Van Kooten and Bulte, 2000, pp. 271-285 and Mace and Balmford, 2000). In view of these dire predictions over habitat and species endangerment, the conservation community has anticipated that "the number of species maintained solely in captivity are likely to continue growing in the foreseeable future" (Magin *et al.*, 1994, p. 24). For example Heywood and Stuart (1992) estimate that by the year 2015-2020 nearly half of the worlds current threatened bird species (450/1029 or 44%) will be maintained solely in captivity. This is to be contrasted to the 3% figure of current endangered birds conserved solely in captivity today (Table 5.2). Further, it is predicted that in the next 50 years 1500 megafauna will become endangered. This figures includes mammals, reptiles and amphibians but not fish birds, and insects. It is estimated that *ex situ* resources have a carrying capacity of 'hosting' 1000-2000 species thus potentially being able to 'solve' a considerable part of the problem (Cain and Merrit, 1999).[8] Also, the social appeal of many charismatic species places them on the top of the list for inclusion in these programmes (Metrick and Wietzman, 1996). Associations and NGOs such

[8] The capacity of *ex situ* facilities was considered to be adequate to save just 100 species (Conway (2000). This is one of the reasons why economists have modelled wildlife values as an increase function (at a decreasing rate)

as the World Zoo Conservation Strategy (WZCS), the Conservation Breeding Specialist Group (CBSG) and the American Association of Zoological Parks and Aquariums (AAZPA) are advocating the adoption of an increasing number of *ex situ* programmes. The majority of the plans call for a 200-500 year commitment to keep these species in captivity (Foose, 1993). Yet, the majority of these programmes "have no contact of any kind with any reintroduction programme" (Hancocks, 1994, p.181). Clearly, these species are condemned to remain in captivity forever since it is doubtful that the habitats required for their re-introduction will be available in the future. The species "will be all dressed up and have no place to go" (Loftin, 1994).

5.2.3 Transfer of technology arguments for *ex situ* conservation programmes

The 1150 captive breeding facilities currently in existence are located in 83 countries worldwide. Yet, only 25% of these programmes are located in developing countries. For example the entire African continent has only 32 institutions, while S. America 29, Central America 16 and Asia 55 (excluding China and Japan) (Magin *et al.*, 1994). Yet, developing countries are considered to be areas of high species richness with relatively more endangered species. It therefore seems unlikely that *ex situ* programmes - 75% of which are located in the developed world - have contributed to enhancing species richness in the developing world.[9] What is more, several authors have raised concerns that *ex situ* polices "are one more part of a larger process of moving the 'natural genetic wealth' of the south to the north." (Swanson, 1994b). This raises important distributional and property rights issues. For example, to whom do the species 'belong to' once included in the breeding programme? Representatives from the captive breeding community claim that wild animals are part of the "global commons" and advocate that they be "owned in trust by the entire managing partnership hopefully for the collective good" (Koontz, 1994). Yet, the composition of the partnership and the obligations of the partners remain

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of stock size. Yet, advances in science coupled with an increase in funding for *ex situ* polices have increased their capacity to be able to sustain up to 2000 species.

[9] One may argue that we observe relatively more *ex situ* programmes in the developed world precisely because it has relatively less 'free' habitat or less habitat at 'socially affordable' opportunity cost compared to developing countries. Yet, the point made here is not about *why* ex situ programmes are more readily found in the developed world but rather to examine whether the assertion made in support of *ex situ* programmes (that they involve transfer of technology that helps increase in situ stocks in developed countries) is justifiably made.

obscure. It is just this kind of argument that the south has attacked. For example in the 1992 United Nations Conference on Environmental Development in Rio many voices from the south contended that the north wants access to resources of the developing world without adequate compensation for them (Eudey, 1994). In addition, others have raised concerns over how genuine development can be achieve if the south is stripped of its unique resources and capabilities (i.e. it's 'comparative advantage') (e.g. Swanson and Barbier, 1992; Swanson 1994b). Such forces of resource 'appropriation' should not be underestimated. For example Fred Koontz who is the director of the Science Resource Centre for the Wildlife Conservation Society and head of the IUCN Species Survival Commission and the Captive Breeding Specialist Group has stated that the "*plain fact* is that the animals would *without a doubt* receive better care in a modern zoo in a *developed country* than *any* facility that could be built and serviced in a less developed area" (emphasis added) (Koontz, 1994). Hence, the arguments that *ex situ* conservation programmes involve technological transfers to the developing world so as to enhance *in situ* stocks does not appear to be particularly convincing and sincere.

5.2.4 Supply side arguments for *ex situ* conservation programmes.

Some economists have argued that supply side *ex situ* programmes may offer a means of alleviating pressures on the stocks of wildlife species that are used for the production of certain consumptive goods and are thus threatened by poachers. The recommendation is to flood the market for wildlife commodities with captive–bred varieties and other alternatives. This will depress prices, and make poaching unprofitable. Poachers will search for alternative employment allowing wild populations of endangered species to recover. The supply side arguments are not readily accepted by most conservationists although they appear to be gaining support.[10] Such captive breeding programmes have been recommended as a way to ensure a steady supply of bear bile, tiger bones and rhino horn, thus potentially protecting wild bears (Mills *et al.*, 1995), tigers (Siedensticker *et al.*, 2000) and black rhinos (Brown and Layton, 2001). Similar policies have been recommended to curb the illegal trade in live

[10] For example, Damania and Bulte (2001) quote an influential publication that while referring to the poaching of the tiger asserted that:

> "If the global captive population of tigers were managed like a cash crop... in no time the domestic tiger would be an important economic resource and poaching wild tigers would be about as profitable as hunting for hen eggs in the jungle" (Asiaweek, 1993).

endangered species such as birds and reptiles (Commonwealth of Australia 1998). Yet, Damania and Bulte (2000) have shown that under certain plausible institutional and market arrangements such supply side polices may in fact reduce *in situ* stocks. They base their analysis on examining the implications of imperfect competition, product differentiation, laundering effects and changing consumer preferences that characterise the market for wildlife products.

Even if these problems were accounted for, demand for animal products affects only a very small number of wildlife and concerns a relatively small number of (global) consumers. Hence, supply side arguments for *ex situ* breeding of wildlife as leading to increases in wild stocks are not that relevant for the vast majority of species. Ultimately, *in situ* wildlife conservation requires that the forces that lead to habitat conversion be addressed.

5.2.5 Public awareness and support arguments for *ex situ* conservation programmes.

The role of breeding programmes in zoos as educators of the public of wildlife issues is troublesome since it is not clear what exactly people learn from visits to zoos and how this knowledge helps *in situ* conservation. Several authors have raised concerns that zoos provide a distorted picture of nature and wildlife as well as perpetuating the view that environmental problems can be addressed via 'artificial solutions' (e.g. Loftin, 1994).[11] Moreover, in 1994 the total annual global budget for *ex situ* programmes (including zoos with breeding programmes) amounted to US$3 billion. Note that since 75% of such institutions are located

[11] There are several other concerns that have been raised against the use of *ex situ* programmes on the basis that they expedite the loss of *in situ* stocks. For example, some argue that *ex situ* policies are an organic rendition of Gresham's Law, in which *ex situ* species drive out *in situ* species (bad money drives out good money) as the resources necessary for *in situ* conservation are sapped by the perception -inevitable as *ex situ* stocks rise- that there are 'plenty' of species (Meacham, 1997). That is, it has been argued that *ex situ* programmes divert attention and funds from *in situ* programmes by giving a false sense that they are 'solving the problem' of species extinction. Further, others have seen captive breeding programmes as an excuse for zoos to profit without contributing to *in situ* conservation. The pretence of a captive breeding programme provides a loophole in the various legislations governing the trade of species (e.g. CITES). For example, the EU Directive 3338.97, which prohibits the trade in wildlife species listed in IUCN's Annex A for commercial purposes, is circumvented by many marine parks in the EU (mainly in Spain and Portugal) who import listed aquatic mammals from the developing world. Others argue that *ex situ* programmes that focus on endangered species often capture wild animals which leads to the disruption of the already fragile structure of the wild stocks which in turn further

in the developed world it follows that the bulk of these funds were spent there. In the same fiscal year, the total management budget of the 4300 protected areas in the developing world amounted to only US$0.5 billion (Magin *et al.*, 1994). This stark imbalance in figures suggests that *ex situ* programmes are not contributing financially to their *in situ* counterparts and that they are even distracting funds away from habitat conservation.[12]

5.2.6 Cost Effectiveness arguments for *ex situ* conservation programmes.

Proponents of *ex situ* programmes often claim that in many cases society is "faced with no other choice" but to conserve a species in captivity since habitat preservation is "impossible" (e.g. Olney *et al.*, 1994). It is argued that even if we concede that re-introduction will never take place (because suitable habitat will not be available) it is still preferable to save the genetic information contained in a species than lose it forever. In economic terms, policy makers are implying that the opportunity cost of *in situ* conservation is too high and, hence, *ex situ* conservation is advocated on its alleged relative cost effectiveness. For example, the *ex situ* conservation of the tiger (Meacham, 1997) and the red wolf (Olney *et al.*, 1994) are being pursued on the basis of their cost effectiveness.

However, the relative cost effectiveness of *ex situ* policies is far from certain. For example, some estimates report that it costs 50-100 times more to maintain a single elephant in captivity than in the wild, while rhinos cost 15-20 times more (Magin *et al.*, 1994, p. 29; Alibhai and Jewell, 1993). On the other hand, we should be cautious before unambiguously concluding that *in situ* policies are more cost effective than their *ex situ* counterparts. Though the relative cost effectiveness of *in situ* policies may be true for certain large species it is not clear that this claim can be generalised to other types of species with different needs. First of all, the costs of *in situ* conservation are usually grossly underestimated. This is because they usually include only the running costs of nature reserves and not the entire set of opportunity costs of

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hastens extinction. Hence, the alleged 'necessity' of the *ex situ* programme is a form of self-fulfilling prophecy (Lofitn, 1994).

[12] See McKinnon (2000) and McNeely (2000) for how *ex situ* policies are distracting funds from *in situ* wildlife conservation

conservation.[13] Of these, the opportunity cost of habitat preservation is likely to comprise the largest component of total costs. These costs may escalate in developing countries which rely on labour intensive agricultural or extractive uses of land. Such uses imply that land has a lower productivity per hectare thus fuelling the need for further land conversions. Therefore, accounting for the full set of opportunity costs would not necessarily make *in situ* conservation appear as a relatively cheap option. Secondly, advancements in cryobiology and birth control techniques have allowed captive breeding facilities to maintain the genetic diversity and integrity of a particular species using a smaller pool of animals. In essence these techniques lower the minimum viable population level for captive species. Cost reductions are achieved since fewer animals need to be maintained at any given period of time. (Wildt *et al.,* 1997). Hence, it appears that on cost-effective grounds there may be a case for *ex situ* policies.[14]

Yet, cost-effectiveness arguments may still be unsatisfactory since covering the operating costs of the captive breeding facilities themselves may not reflect the full range of their social costs. More importantly, concerns have been raised as to the well-being of species preserved in captivity (see Norton *et al.* 1995 and Olney *et al.* 1994 for a review). In the anthropocentric value system of economics such concerns for the welfare of captive animals would be expressed as forms of altruism modelled with the help of an interdependent utility function. Individuals who feel altruistic towards species include a 'species well-being function' in their own utility function and would thus receive a welfare loss if the welfare of a species were to be seriously jeopardised. Such welfare losses may be estimated with the aid of stated preference techniques. These costs have not been considered when claims about the cost effectiveness of *ex situ* policies are made.[15] Moreover, the cost effectiveness of captive breeding programmes have not included the costs of maintaining excessive stocks (i.e. animals

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[13] The social (opportunity) costs of *in situ* wildlife conservation programmes (such as the US Endangered Species Act) include the public resources devoted to endangered species but also foregone opportunities due to restrictions on the use of property due to listings, designation of critical habitat, and recovery plans as well as the reduced economic rents from restricted or altered development projects, agriculture production, timber harvesting, minerals extraction, recreation activities, wages lost by displaced workers who remain unemployed or who are re-employed at lower wages, lower consumer surplus due to higher prices, and lower capital asset value. Moreover, opportunity costs would include the transaction costs of administrating the conservation programme such as time and money spent applying for permits and licenses, redesigning plans, and legal fees (see Brown and Shogren, 1998)

[14] This conclusion is further reinforced if we add the monetary benefits from *ex situ* conservation (e.g. zoo revenues).

beyond the minimum viable population). Breeding excess animals is inevitable despite scientific efforts to control their number. Yet, captive breeding specialists acknowledge that the costs of looking after such excess animals can be enormous. For example, Lindburg, a behaviourist at the San Diego Zoo, estimates that an orangutan declared surplus at age 20 would require another 10 years of care, which would cost some $44,000 (Sunquis, 1995). The price tag for looking after the 88 surplus orangutans currently in North America is estimated at $3.8 million (Sunquis, 1995). Hence, in the absence of estimates of the full social costs of *ex situ* and *in situ* policies it is difficult to make *a priori* cost-effective arguments.

5.3. Defining Wildlife Values

Common welfare theoretic definitions of wildlife values that have been used to formulate scenarios for CV studies are presented in Freeman (1996), Fredman (1993) and Loomis (1988). These authors have modelled wildlife value as a function of the stock of a species. This uni-dimensional approach implies that all forms of values (including existence values) are a function of a single characteristic of the species, its stock size. This conceptual framework would be sufficient to formulate CV scenarios when the main policy issue at stake was the preservation of a specific stock size. Van Kooten and Bulte (2000), Loomis and White (1996), and Jakobsson and Dragun (1996) provide an overview of single species CV studies. The majority of these have estimated wildlife existence values for maintaining a certain stock level. These estimates have provided useful input into policy decisions concerned with determining the optimal level of *in situ* stocks. Yet, this conception of existence value may have little relevance under the current conservation policy setting that also includes decisions over the 'means' or 'quality' of conservation. Would existence value, defined as the value for preserving the stock of a species driven by a sense of altruism or stewardship be equally consistent with *ex situ* conservation polices? The conservationist Cory Meacham urges policy makers evoking existence values as an argument for the conservation of the tiger to "Forget the tigers!" since:

> "It's not the animal itself that motivates us. If it were, no distinction would need to be made between wild and captive tigers. Seeing a tiger in a cage would be just as satisfying as seeing a tiger in the *wild*.

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[15] See Clinch and Murphy (2001) for a discussion of the implications of including both winners and losers in cost benefit analysis of public goods.

But it's not, and the reason it's not is because wild tigers are wild. It's not the tigers that motivate us, it's their *wildness*. If wild tigers go extinct, we won't have lost the tiger, but we will most certainly have lost a chunk of wildness." (Meacham, 1997) [16]

This reasoning brings to the surface a point that has eluded the environmental economics literature, namely that some wildlife values are more readily associated with and best modelled by reference to quantitative aspects of a species such as its stock size, while others with reference to the quality of species conservation, such as degree of wildness or naturalness. This interpretation of existence value is not novel. A closer reading of the conceptual work on the notion of existence value suggests that this category of value is associated with some characteristic of the species beyond its stock size (e.g. Krutilla, 1967, Randall and Stoll, 1983, Freeman, 1993a and 1993b; Pearce and Turner, 1990). Yet, the subsequent analytical and empirical literature on existence values has downplayed the importance of the distinction between the quantity and quality of species conservation, primarily because it has been operating under the assumption that all conservation (ultimately) takes place *in situ*. That is, the level of conservation quality has so far been kept constant. Once this assumption no longer holds universally and intrusive and *ex situ* policies are seen as alternative conservation approaches (affording different levels of species quality) then the importance of this distinction when discussing existence values resurfaces.

5.3.1 Existence value 'reconsidered' but not revised.

In this study we employ an alternative definition of value that explores other facets of wildlife value. We will focus on both the impact of the quantity (or stock) of wildlife in valuation decisions, and also on the impact of the quality (or welfare) of wildlife. That is, our definition takes into account that wildlife conservation policies have multidimensional impacts on the state, q, of a particular species, affecting both its quantitative aspects as well as its qualitative

[16] Such appeals from members of the conservation community are increasing. For example the environmentalist Tania Unsworth referring to *ex situ* efforts to save the tiger wrote (Guardian, Saturday November 25, 2000):

> The environmental arguments aside, the most compelling reason to continue to fight for the [*in situ*] tiger is an *emotional one*. We may admire the animal for its looks, its power, but what we love about the tiger - what truly stirs our imagination - is something far harder to define: *its wildness* .... Some essence - as fundamental as the stripes on its back - seems lost forever once it is put behind fences. We need wild tigers. We need them because they are the closest we come to the creatures of myth - to unicorn or minotaur. There was a time when we barricaded our doors against the animals of the night. Now we sleep easier knowing they are still there."

aspects. Thus, the definition of value used here treats q as a vector.[17] It is argued that this conception of wildlife value is more relevant under the realties of current *ex situ* conservation policies.[18]

For convenience we assume that q consists of two dimensions, the quantity and the quality of a species' existence, $q = (q_1, q_2)$. The former is assumed to be measured by stock size while the latter is measured by the quality of the environment afforded to a species. Most wildlife conservation policies would impact on both elements in q. Individual WTP for a change in stock size, q_1, would be associated with the values obtained from preserving the genetic

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[17] Several economists have cautioned that q need not be viewed as a single scalar measure but as a vector of attributes and that different elements of this vector may give rise to different values. For example Kopp (1992) points out that "what is certainly clear is that elements of the vector q that are appropriate for the motivation of use values … may not be well-suited to the motivation of non-use values" (p.28). Also, Freeman (1993b) states that:

> "q is taken to be a scalar measure of some characteristic of the environment, for example, the population or biomass of some species or the value of some parameter of water quality. In the abstract, q can represent either quantity or a quality measure. (p.19). The choice of a unit for measuring q has important implications for measurement in practice. But the question is not addressed here. The assumption that the environmental resource can be described by a single attribute is clearly a simplification. A more realistic model would allow for simultaneous changes in two or more quantitative and/or qualitative characteristics of the resource." (p.19).

Elsewhere Freeman (1993a) states that environmental quality "cannot be represented by a single number on some scale, but rather is an n-dimensional vector of the relevant parameters" (p.35) and acknowledges that different values should be characterised by different attributes in q (p.34-35). Yet, he concedes that how to deal with this issue is still "a major question for research" (p.35). Though several authors have acknowledged the importance of specifying q as well as its multidimensional, as opposed to unidimensional, nature most economists still use a single dimension to specify q when defining all forms of value. The convention of choosing a single scalar to define and measure existence value is mostly due to difficulties with identifying appropriate attributes of q that give rise to existence values. Identifying which characteristics of a species attribute inherent worth or which characteristics are associated with sentiments of stewardship or sympathy towards species is not an easy task. This is further perplexed by the non-market nature of these values which entails that we cannot rely on observed behaviour to deduce existence value attributes. Economists are left with observations over what affects utility for use goods and have, thus, conveniently assumed that the attributes in q that are important for use will also be important for non-use (Kopp 1992). Yet, most economist agree that existence values constitute a fundamentally different category of value and hence using the same attribute to define both existence value and other forms of value may be inappropriate. For example the population density of a fish species may be relevant in defining values for recreational fishing but may not be appropriate for discussing various forms of non-use values.

[18] In addition to such conceptual difficulties, there are some empirical anomalies observed in CV studies that may also be associated with attempts to define existence value simply in terms of species stock. For example, several authors have pointed out that traditional convexity assumptions seem inappropriate when discussing existence value in terms of species stock (e.g. Carson and Navarro, 1988; Kopp, 1992; Brookshire, Eubanks and Sorg, 1986; Kopp and Smith, 1993). Further, some critics have observed that CV estimates are not sensitive to changes in the size of the stock of the species. Yet, these apparent anomalies may be due to the wrong choice of the dimension to characterise q in the CV study. This point has not received much attention in the literature debating scope and existence values (e.g. Carson *et al. 1994*; Bateman *et al.*, 2001). A rare exemption is the work by Raymond Kopp (see Kopp, 1992).

material of a species. In contrast, WTP for changes in species quality, q_2, is to reflect a form of altruistic value towards the species itself. More specifically, in economic (anthropocentric) terms preferences for species quality can be modelled using a paternalistic altruism utility framework. The individual (altruist) obtains utility when the beneficiary (species) receives or 'consumes' certain resources (e.g. land).[19] Using a paternalistic altruism framework for the value for species quality is very useful since it avoids the conceptual difficulties of positing and discussing a utility function for the species itself.[20] Hence, the individual preference function may be specified as $u = u(x,(q_1,q_2))$, where x is the composite good. Then, for a specified level of $q = (q_1,q_2)$, income m and market prices p, we can describe the well-being attained by each individual from species conservation by an indirect utility function $v = v(p,q_1,q_2,m)$. For an initial level of income m^0 and species quantity/quality q^0, the initial or reference level of utility would be given by u^0. Then the dual optimisation problem min $e(p,q_1,q_2,u)$, $st.\ u = u(x,(q_1,q_2)) \geq u$, would yield compensating demand functions for x as well as Hicksian compensating or equivalent welfare measures for changes in the vector q. For a multidimensional policy change that results in the simultaneous change in two or more dimensions in q, the Hicksian compensating welfare measure is the amount of income paid or received that would leave the individual at the initial level of utility subsequent to the multiple impacts of policy. For the change from q^0 to q^1 a holistic measure of value is represented by:

$$WTP(q^0,q^1) = e(p,q_1^0,q_2^0,u^0) - e(p,q_1^1,q_2^1,u^0) \qquad \text{Eq. 1}$$

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[19] Of course wildlife 'quality' or 'animal welfare' can be perceived in a plurality of ways. For example some individuals may hold a utilitarian animal welfare stance, akin to that developed by Jeremy Bentham and John Stuart Mill and more recently by John Passmore (1974). Other may hold a 'species holism' position - akin to that popularised by Aldo Leopold- while others may aspire to an animal rights view, such as purported by Tom Regan (1983) and Peter Singer (1978). Yet, a common element in all such positions is that species quality and wildlife animal welfare have something to do with the 'wildness' of the species. Hence, in economic terms we can assert that marginal existence or animal welfare value is the amount of resources allocated for degrees of wildness of a species. Resources associated with the quality or wildness of a species may vary. One reasonable candidate is the amount of space or land provided per species. Yet, these resources need not be restricted to land. For example, they may take the form of institutional or legal measures that secure that species are managed in a particular less intrusive and disruptive manner.

[20] Interpreting individual preferences for species quality in terms of paternalistic altruism directly follows from the conceptual work by McConnell (1997).

Component values can be subsequently defined from Eq. 1 by using a simultaneous valuation path that begins at $q^0 = (q_1^0, q_2^0)$ and ends at $q^1 = (q_1^1, q_2^1)$. The simultaneous valuation path values the effect of each element of q as the *overall* vector changes from q^0 to q^1. The disaggregated expression for Eq. 1 is then given by:

$$WTP(q^0, q^1) = \int_{q^0}^{q^1} \left[\frac{\partial e(p, q_1, q_2, u^0)}{\partial q_1} \right] dq_1 + \int_{q^0}^{q^1} \left[\frac{\partial e(p, q_1, q_2, u^0)}{\partial q_2} \right] dq_2 \qquad \text{Eq. 2}$$

where each of the two components of Eq. 2 evaluates a derivative of the expenditure function $\partial e(p, q_1, q_2, u^0)/\partial q_i$, $i \in \{1,2\}$ as the overall wildlife conservation policy shifts from its initial to its post-policy level (Hoehn, 1991). Using this framework we can allow for different forms of value to be a function of different dimensions of q.

We will assume that there are two main values that people hold for remote species such as the Giant Panda.[21] These are 'gene flow values' related to the preservation of the stock of the species, and the 'existence values' related to the subjective value from the perception that we are preserving some quality of life for the species. These last types of values could be related to benefits humans derive the perception that a specific level of animal welfare is provided to the species by means of preserving it in a natural and undisturbed environment.[22]

[21] Also, other forms of values such as recreation values have been found to be insignificant with respect to how much they can contribute towards conservation. For example, Barnes, (1996); Bulte and van Kooten, (1999). Brown and Shogren (1998) argue that ecotourism receipts are not sufficient to preserve species at a large scale. This is partly because the choke price for the recreational viewing of popular megafauna is sufficiently large to drive most 'world consumers' out of the market and partly because *in situ* recreational viewing of most species (particularly the less charismatic ones) is simply not in the preference functions of most people. Recently Alexander (2000) has generalised the bioeconomic models of species extinction of Clark (1973) and Swanson (1994a) by including NUVs as separate argument in the objective function. He shows that direct use values (including values from wildlife products and recreation) are not sufficient to provide the incentives for *in situ* conservation. His analysis concludes that for most species appropriation of option and existence values from the developed world provides the only means to sufficiently cover the opportunity costs of land and other resources required for species conservation in the developing world

[22] Note that all other forms of value such as recreational values and bequests are not considered here since we are considering remote species for which very few use values exist. Also, existence values mentioned here are anthropocentric in nature. Non-anthropocentric conceptions of animal welfare are not considered here.

Gene flow values would then be defined as the welfare obtained by a change in the level of wildlife stock keeping the quality of life constant (the first part of Eq. 2). Existence value would be defined as the value for a change in the level of species quality or well-being (as perceived by humans) while keeping stock levels constant (the second part of Eq. 2). Defined in this way, *the existence portion of this value is the marginal willingness to pay for the conservation of a species - in addition to that which is offered for its mere biological preservation.*

In effect, in this study we are decomposing so-called wildlife values into distinct genetic and existence value components. Freeman maintains that formal definitions of existence value are a "matter of taste" (Freeman, 1993b). Yet, the merit of any formal definition lies in its ability to better explain human behaviour, in its capacity to construct meaningful empirical hypotheses as well as in how well it conforms to the intuition underlying a particular concept. The definition of wildlife value presented above seems to better satisfy these requirements compared to the standard formal definition. First, the definition of value provided here allows for a simultaneous change in more than one attributes of q which captures the realities of conservation policies. Secondly, it captures the idea that different elements in q may be associated with different component values. This allows for a definition of existence value that does not depend on species stock. Instead existence value is best seen as being related to other aspects of wildlife conservation and includes both animal welfare as well as (implicit) biodiversity values. Lastly, this definition of existence value can be viewed as capturing the spirit underlying the conceptual work on existence value (e.g. Krutilla, 1976; Pearce and Turner, 1991). Hence, we presented a 'reconsidered' but not revised conception of wildlife existence value that appears to be more relevant under the new emerging policy conditions of wildlife management.[23]

[23] Krutilla's initial conception of value for the preservation of environmental resource in general and wildlife in particular implies that it stems from two dimensions: the first is that the species must 'exist' while the second is that it must exist 'in the wild'. Krutilla acknowledges that the first dimension may provide gene flows for which people may have option and bequest values (p. 780, 784). Further he implies that individuals obtain *additional* utility/benefits when species are allocated more resources (namely habitat) than those required for the mere preservation of their stock. Krutilla acknowledges that these 'added benefits' may take the form of option, bequest or altruistic values for *in situ* use of the species (most likely for recreational viewing). However, he argues that values for "exotic species in remote areas of the world" for which few people "ever hope to see", are not motivated by future demand to view or use the species in question. Instead they are the values for the "mere existence" and "widespread distribution" of these species (p. 781). Further, Krutilla attributes these values to an

5.3.2 Empirical Decomposition of Component Values

The preceding section discussed how wildlife value can be defined in terms of the simultaneous change in two attributes of the species and how component values (such as existence value) can be theoretically decomposed. This section turns to how total values can be empirically disaggregated into different benefit components.[24] Gaining a better understanding of the relative magnitude of component values may prove important in practice because it may affect how value estimates are interpreted and used in making policy decisions. The emphasis of this discussion will be on how value decomposition can be achieved in CV studies.

Although it is relatively straightforward to decompose values in theory it is more likely that individuals participating in CV studies provide a holistic assessment of their value rather than a conscious summing of the several components to reach a total value. This view of the valuation decision has lead valuation experts to be sceptical of attempts to ask respondents to separately value the several benefit categories they may hold for a given amenity (Mitchell and Carson, 1989). It is difficult enough for respondents to evaluate the desirability of an amenity as such. To ask them to say how much they would be willing to pay just to know that others, but not themselves, can use the amenity is even more difficult.[25] Mitchell and Carson (1998) have labelled the "fallacy of motivational precision" as the error committed by CV practitioners when they assume that respondents are aware (to the degree of precision desired by the researcher) of what motivates their value judgements. (p.288). There are four

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"*exclusive* sentimental basis" (p.781) motivated by a sense of "public responsibility" (p.785) to categorically distinguish them from any "option demand" (p. 780) or "bequests" (p.781) which according to Krutilla are expressions of "normal private economic behaviour" (p. 785). Lastly, closer reading of his work suggests that the source of utility from existence demand stems from "natural phenomena" that have not "[undergone] fabrication or other processing". Even if "fabricated replicas" were made possible (Krutilla refers to resurrecting extinct species) he doubts that they would have values equivalent to that of the originals. (p. 783). Hence the spirit underling Krutilla's work is consistent with the idea that wildlife existence value is the maximum amount of resources that society would be willing to allot to a species *in addition* to those required for its mere genetic preservation.

[24] This section is largely based on Mitchell and Carson (1989) pp.288-290.

[25] Such difficulties would extend to actual market transactions. For example most consumers, if asked to value each of the aspects of a newly purchased car in an open-ended fashion, would have trouble saying with any degree of precision how much they would be willing to pay, say, for the styling, the horsepower, or the prestige from ownership etc.

measurement strategies that have been used by the CV literature to obtain estimates of the various types of benefits that the respondent receives from wildlife conservation. Each strategy performs differently with respect to overcoming the fallacy of motivational precision.

A first strategy would be to individually described each benefit category to the respondents and then ask them directly how much each dimension of wildlife conservation is worth to them. If separate values for direct use, indirect use, and existence are obtained in this way, the total WTP amount for the good could theoretically be obtained by adding the values. Although this strategy has the advantage of simplicity, and studies using this approach have succeeded in getting respondents to give dollar answers to the questions, the potential for invalid or meaningless answers is high because of the fallacy of motivational precision. It is also a dangerous strategy because it stands a chance of grossly overestimating total WTP. (Mitchell and Carson, 1989; Randall, 1991). A second decomposition strategy involves asking respondents to separate a previously obtained total WTP amount into values for one or more benefit components (e.g. Walsh *et al.*, 1984) This strategy is preferable to the previous one in that it first obtains a presumably valid total WTP amount before attempting to break that amount into potentially invalid component values. Obtaining the total WTP amount first also helps respondents to grasp the idea that the component values are a subset of the overall value. (Mitchell and Carson, 1989). A third strategy uses reported use and/or anticipated future use of the good to indirectly estimate existence value. On the basis of self reports, the respondents are divided into those who use the amenity and those who do not. Then WTP amounts are measured for each group (e.g. Bateman and Langford, 1997). The WTP amounts for the amenity given by the nonusers are treated as a relatively pure expression of non-use or existence value, whereas the users' WTP amounts include some combination of use and implicit values. It is usually assumed the 'users' non-use value would be equal to the average non-use values of 'non-users'. This allows for disentanglement of the mixed value provided by users. Mitchell and Carson (1989) warn however that since no defensible external criteria are available to determine which portion of the users' WTP amounts should be assigned to the existence category, estimating existence values by this approach could be over or underestimating existence benefits. Moreover, it is not always feasible to distinguish between users and not users in the first place. A fourth strategy involves posing two or more scenarios to separate sub-samples or, if budget does not allow, to the same respondents. The scenarios differ only with respect to the specific benefit component the researcher desires to measure. The difference between the total WTP amounts between the two scenarios yields an estimate of the desired quality. This approach avoids the fallacy of motivational precision since it asks respondents to give a total (holistic) value only for a given scenario. Despite its appeal this approach has not received much attention by CV practitioners.[26] The study presented in this chapter uses this 'scenario difference' approach in order to disentangle the total values held by non-Chinese for the Giant Panda. Due to budgetary constraints a split sample approach could not be used and hence the same respondents answered several WTP questions. This approach avoids some of the problems with the strategies for decomposing values but at the same times raises some other issues concerning the estimation of multiple responses from the same individual.[27]

5.4. The Paradox of the Giant Panda

The Giant Panda (*Ailuropoda melanoleuca*) is one of the world's most well known and popular species. It has been cherished due to its external appearance and mysterious behaviour and has even served as a symbol for biodiversity conservation in general by being adopted as

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[26] The only example is provided by a study by Curtis (2000) who tried to obtain estimates for animal welfare associated with managing a deer population in the suburbs of Maryland, Washington D.C., USA. A split sample design was used in which the first sub-sample was asked for their WTP for a programme that would manage (i.e. curtail) the number of deer by using sharpshooters. A second sample was asked for their WTP for maintaining the same number of deer (and hence the same number of use benefits that come from the size of deer stock) but the deer population would be managed via a birth control programme. The assumption being that the second programme would also generate some form of animal welfare benefits. In line with the above discussion the value for animal welfare would be the maximum amount of resources society would be willing to allot for managing deer population in addition to the sharp shooting programme. WTP for sharp-shooting was estimated at $147/year. This represents the value for the benefits for having a managed deer population. The birth control programme, valued at US$165, included both these use benefits but also the animal welfare benefits. Hence, Curtis finds that the surveyed Maryland households are WTP an extra US$18/year for attaining a certain level of deer animal welfare.

[27] Beyond the standard CV method, the choice modelling approach may prove another useful avenue to decomposing values. This is so since choice modelling explicitly utilises a multi-attribute utility framework and hence would be in line with the multi-dimensional conception of value presented here. Existence value would then be defined as the ratio of a programme attribute associated with existence or animal welfare value (e.g. land) over the 'price' attribute of the programme. The use of choice modelling for the estimation of existence value consists an important field for future research.

the official logo of the World Wild Fund for Nature.[28] At the same time, the case of the Giant Panda exhibits an interesting paradox. This paradox has two dimensions. First, this widely recognisable and cherished species is one of the most endangered animals in the world with less than 1000 pandas still remaining in existence in the mountainous regions of Sichuan Province, China (Schaller, 1993). Secondly, despite being the best example of a flagship species that has been used to promote the 'species' approach to biodiversity conservation, the conservation plans for the Panda itself mainly focus on the *ex situ* breeding and maintaining of the Panda stock with almost no provisions for re-introducing the species back to its natural habitat.[29] This paradox makes the panda an instructive case study for exploring the questions raised in the introduction.

5.4.3 Paradox of in situ Panda Conservation

Contrary to popular belief the reasons for the curtailment in the panda population have little to do with shortages in their main food supply (bamboo), with problems of illegal poaching or with difficulties in mating or procreating. Instead, the primary force hindering the preservation of the panda population is the continuing subsistence use of the panda habitat by local communities (Liu *et al.*, 2001; Zhi *el al.*, 2000; MacKinnon and De Wulf, 1994). Figure 5.1 depicts the historical dispersion of the panda and the restriction of its habitat. In response to this habitat encroachment, the Chinese government has designated 25 nature reserves in Sichuan province occupying a total area of about 11,500 km^2 for the protection of this unique species. The same figure shows the distribution of 12 of the largest Panda reserves. The most

[28] The WWF (using the Panda logo) raises about $150m from its 5 million supporters world-wide. The interest in the panda itself is manifested in many ways. The Panda is known among zoo managers as being one of the top revenue earners. For example the attendance at the Atlanta Zoo jumped from 750,000 to one million visitors a year upon of the arrival of a pair of pandas in 1999 (Environmental News Network, February 21, 2000). Other manifestations of its value include number of inter-net sites, toys, cards etc. devoted to the panda that outrank most (if not all) other species. Despite its current appeal the species was virtually unknown to the Western world till the late 19th century. Even in China it has been only recently that the species has been elevated to a national symbol. For example, the presence of the Panda image on Chinese historical artefacts (such as pottery images) is surpassingly entirely absent. This could be due the isolationist behaviour of the Panda. The reasons why this particular species acquired its current prominent status among flagship species has been attributed by George Schaller - the prominent Panda scientist – to its curious physical characteristics and mysterious habits (Schaller, 1993). In addition, the panda became a symbol of international friendship during the cold war era when China offered pandas to Western leaders as tokens of friendship.

[29] A more thorough presentation of the institutional forces behind this paradox can be found in Swanson *et al.* (2001) and Swanson and Kontoleon (2000). Also, see Liu *et al.* (2001), Zhi *el al.* (2000); MacKinnon and De Wulf (1994), Schaller (1993), Mackinnon *et al.* (1989) on the plight of the Giant Panda.

well known panda reserve is the Wolong Reserve that hosts that largest population of pandas (about 10% of remaining stocks). Yet, as has happened in most other developing countries, the parks and protected areas approach has failed the Giant Panda Reserves as well. The lack of appropriate funding, the lack of local incentives and benefit sharing and the inefficiencies of bureaucratic management have rendered these areas into mere 'paper parks'.

However, the designation of reserve status and the implied restriction on uses has engendered resentment amongst the local peoples. In fact, the panda reserves in Sichuan Province have come at the expense of lost opportunities for some of the poorest people in that country (MacKinnon and Wulf, 1994). This alienation of local people implies the need to expend governmental resources on the monitoring of the reserves. In addition, the economic restructuring that is taking place within the rapidly changing Chinese economy increases pressures on the local people, and consequently on the reserve and the officials charged with its monitoring and implementation. The government has also attempted to implement resettlement programs in order to move settled peoples outside of the Reserves. This cycle leads only to the increased degradation of the reserves, increased poverty of the local peoples and increased pressure on the local officials. Further, central funding for protection activities has not kept up with the pace of nature reserve designation in recent years. [30] As in other sectors of government, the expansion and differentiation of state conservation responsibilities has been accompanied by fiscal decentralization, leaving local/provincial governments with a growing burden. Public sector down-sizing and restructuring have resulted in harsh budgetary cut backs for the reserves. Within this context of increasing restrictions and restricting resources, the reserves are viewed by local governments as a non-productive drain on local fiscal resources. (see Swanson *et al.*, 2001).

A recently published analysis of habitat data from satellite images of the Wolong reserve shows that despite the restrictions imposed on the local people in the reserve and the relatively large sums of money the reserve has received compared to other Panda sanctuaries, the habitat suitable for panda conservation has been steadily shrinking even after the reserve was established in the mid 1970's (see Figure 5.2). It is estimated that the rate of decline in habitat

[30] Panda reserves doubled in the 1990's from 12 to 25.

highly suitable for Panda conservation after the reserve's establishment has been about 0.67% per annum. This decline in suitable panda habitat in Wolong has lead to a decline in the panda population from 145 in 1974 to 72 animals in 1986. Based on wildlife-habitat relationships and the decreasing frequency of finding pandas in the wild the current number of wild pandas in Wolong is likely to be even smaller (Liu *et al.*, 2001). [31] This decline results from local peoples' subsistence hunting and gathering, and minor logging activities. The total value of such activities has been estimated at achieving returns of no more than a few hundred dollars (in aggregate) per hectare per annum. (Kontoleon and Swanson, 2000).

The first aspect of the Panda paradox lies in the combination of the powerful global image of the panda together with the penurious local circumstances in which it finds itself. While the panda remains one of the most highly visible and notable of the world's charismatic species, it continues in its decline for want of a few thousand hectares of undisturbed habitat.

5.4.4 Paradox of ex situ panda conservation

The Giant Panda is one of the most widely recognized endangered species in the world, partly because it figures as the logo of the world's most prominent nature conservation organisations (i.e. the WWF). As such the Panda has served as a figurehead to promote awareness and raise funds for wider nature conservation. However, the currently applied programme for the conservation of the panda itself is far from natural. In light of the failure of the reserve system, the Chinese authorities have been pursuing a series of *ex situ* breeding programmes.[32] These include programmes in specially designed captive breeding centres in Wolong and Chengdu (the capital of Sichuan Province) as well as smaller scale breeding programmes in various zoos around the world (mainly in the US, Mexico, Germany, Japan, and Hong Kong). Despite the increased success in reducing infant mortality of captively breed pandas, plans for the re-introduction of the species are non-existent. Stuart Chapman of WWF-UK reveals that "of the 400 pandas bred in captivity since 1936 none have ever been released into the wild"

[31] Predictions for decline in panda numbers in other reserves are even dire. For example, a population of 197 pandas in the Wanglang Reserve in 1969 reduced to only 10-20 by 1980 while it is estimated that there are no pandas at present in this reserve.
[32] Also, some human resettlement policies have been attempted but with little success. See Swanton *et al.* (2001)

and that "the captive breeding programme is not making any contribution to wild populations" (Chapman, 2001). Moreover, reintroduction rates are not likely to improve in the future since the issues pertaining to habitat conversion are not adequately addressed. In essence, advocates of *ex situ* Panda conservation policies have thrown in the towel in the battle to save panda habitat *in situ* and are content with preserving the species in artificial surroundings.[33]

As shown in Section 5.2 the Panda is just one out of an increasing number of threatened species whose conservation is pursued with *ex situ* means. The paradox with the panda lies in the fact that the one species in the world that has figured most prominently as a 'flagship' for promoting nature conservation is itself being pushed down the path toward *ex situ* conservation.

5.5. A contingent valuation study for the preservation of the Giant Panda.

A contingent valuation study was designed and implemented in 1998 that examined the relative magnitude of the types of values held by non-Chinese for conserving the Panda. Three conservation policy scenarios were valued, each involving an impact on the population density, the animal welfare levels and the degree of wildness of the species. The total WTP for each scenario was defined as the value for the simultaneous change in the quantity (stock) and quality (living environment) of the species from the current reference to a new level. By design each scenario entailed and/or restricted different types of values. Hence, the difference between scenarios would provide an indication of the magnitudes of relative components of

[33] The latest and most ambitious panda conservation programme pursued in China (Under 'China's Agenda 21'-White Paper on China's Population, Environment, and Development in the 21st Century) is titled the "*Ex situ* conservation of the Giant Panda in Sichuan province". The project seeks to increase the giant panda population, promote its viability, and supplement *in situ* conservation. The main implementing agencies are the Chengdu Research Base of Giant Panda Breeding, the China Conservation and Research Centre for the Giant Panda in Wolong and WWF-China. The time line runs from 1997-2005 and its budget amounts to US$ 7.45 million (of which US$ 3.24 million comes from domestic sources while foreign aid covers the remaining US$ 4.21 million). The programme aims at breeding 80-90 Pandas with a survival rate of 85%. Note that this budget covers the aims of increasing the stock of *captive* pandas and does not cover the costs of *maintaining* these stocks in captivity nor the costs of re-introduction. It has been tacitly assumed or expected by Panda conservation agencies that international assistance will cover these expenses. These expectations are based on the charismatic appeal of the panda coupled with a tendency of presenting captive breeding and keeping of the species as a 'necessity' or 'inevitability'. Results of the success in birth rates of the programme are not available. Yet, even if the birth

value. As explained in Section 5.3.2 this "scenario difference" approach is to be preferred to other approaches to decomposing values (Mitchell and Carson, 1989; Bateman and Willis, 1999). Full details of the study development (focus groups, consultations with experts, and pretesting) can be found in Swanson *et al* (2001). Here we focus on presenting aspects of the survey design that are most relevant for this chapter. The questionnaire is included in Appendix 2 of this Chapter.

5.5.5 Extent of the market and sampling frame.

From the outset the project aimed to investigate that values for Panda conservation held by residences of OECD countries. Yet, the constraints of the project required that the CV study be undertaken in China. [34] This restricted our sampling frame to the population of foreign tourists visiting China. To enhance the quality of the sample a partnership was achieved with the China International Travel Service (CITS) which offered access to tourist groups as well

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target is met it is highly unlikely that the alleged aim of re-introduction will ever materialise since no measures are taken to curb the continuing decline in habitat suitable for panda survival.

[34] The study was part of a much larger project conducted on behalf of the China Council for International Co-operation on Environment & Development (CCICED) that aimed at examining policies for managing China's Panda Nature Reserves. Hence, the design and implementation of the current study had to work within the constraints set by the overarching project. It is acknowledged that all these constraints limit the generality of our policy conclusions. For example, budgetary and time restrictions did not allow for a split sample design and hence all three WTP scenarios were presented to the same individual. Further, the sponsors were mainly interested in assessing the values held by OECD nationals but at the same time required that the study be conducted in China. By default, this limited the sampling frame to the population of foreigners visiting China. Considering this sampling frame posed two important sampling issues. The first had to do with the difficulties in finding a sizeable sample of tourists that would agree to offer 30-40 minutes of their time. Of course, this is a problem with all CV surveys. Yet, this problem is exasperated when tourists are sampled since the opportunity cost of a tourist's time is much larger than if the same person was interviewed in his/her country of origin. The second sampling issue concerned issues of representatives of the sample (i.e. there were very few external indicators - such income indicators- that could be used to select a sampling frame and strategy). To overcome these difficulties an partnership was achieved with the China International Travel Service (CITS) which has a virtual monopoly over organising all tourist tours in Beijing. The sampling strategy consisted of choosing groups of tourists on day tours from Beijing to the Great Wall of China. These consist of lengthy tours which according to the information provided by CITS are undertaken by 80-90% of all tourists that visit Beijing. The CITS offered access to all these tours as well as information that would allow for some basic stratification (nationality, estimated income and age of group) and selection of tour. The survey moderators would then join the sampled tours and interview the group members at a suitable time during the day trip. The CITS had instructed all its tour operators and guides to grant the survey moderators access to almost any tour group. The tours consisted of lengthy bus rides that provided many hours of idle time. Hence, respondents were quite willing to complete the survey at a time that was most convenient form them during their day trip. This strategy aimed at assuring that a sufficiently large and representative sample was collected, ensured that respondent attentiveness was enhanced and that response rates were be maximised. An added obstacle had to do with using different langanges for different nationals as well as different monetary measuers. We wer able to adminsire the survey in Engslsh, Germand and French as well as provde currency convert sheets. Again, it is acknowledged that important groups f toursist (e.g. non English speaking Japense) were excluded from our sample.

as information that would allow for some basic stratification (nationality, estimated income and age of group). This strategy aimed at assuring that a sufficiently large and representative sample was collected, ensured that respondent attentiveness was enhanced and that response rates were maximised.

5.5.6 Description of Scenarios Valued.

In the final version of the questionnaire three different Panda conservation scenarios were chosen.[35] Each individual was asked to value all three scenarios irrespective of his/her answer to the other valuation questions.

Before asking the valuation questions for the three scenarios respondents were provided with information about the Giant Panda, its habitat and distribution. This was provided orally by the moderators. Visual aids such as maps, bar graphs and photos were also used. Participants were informed about the decline in the population of the Giant Panda. Human use and conversion of the habitat suitable for panda preservation was described as its main threat. Also, respondents were told that both local and international demand for Panda products (such as fur or meat) was non existent. This piece of information intended to make clear that there are no direct consumptive uses related to the Panda. In addition, it was stressed that the possibility of viewing these animals in the wild was unlikely thus ruling out any *in situ* tourism (option or bequest) values. Moreover, it was mentioned that the Panda habitat also hosts many plants, mammals, birds and reptiles species but non of these were considered to be rare or under threat of extinction.

Respondents were then informed that the highest concentration of pandas was found in the Wolong reserve, amounting to about 200 animals. The population of pandas in Wolong consisted of both caged animals in the local breeding centre as well as wild pandas in the reserve. It was further stated that conservation efforts would focus on just this reserve since this offers the only realistic chance of saving the species. Moreover, respondents were told

[35] The number of three programmes appeared to be the most that individuals could handle in a valuation exercise. Moreover, the chosen scenarios were the ones that were mostly policy relevant.

that the species can only be saved if its population increases to 500 animals which is considered by scientists as the minimum viable population (MVP) (MacKinnon and Wulf, 1994).

Further, it was explained that the Chinese authorities are contemplating three alternative conservation programmes for the Giant Panda. It was made clear that only one (if any) of the three scenarios would be implemented. Moreover, it was stated that whichever of the conservation programmes was adopted the species would be saved with equal certainty but that the scenarios differed in the means by which this would be achieved. The means of conservation were explained as having to do with the nature of the living environmental that would be allotted to the conserved panda population. Further, it was stressed that without international financial support this goal would unlikely be achieved and the panda would become extinct in the near future. Moreover, it was stated that the programme would be managed by the Chinese authorities, while it would be financed *via* a compulsory airport-tax surcharge levied on all foreign tourists leaving China.[36, 37] Finally, the payment ladder approach was used to elicit WTP values.

[36] Finding an agreeable and credible means of appropriating values for global public goods (such as non-use goods) is particularly troublesome. Most respondents understood and were familiar with the practice of raising international funds for species conservation. Hence the idea of 'global responsibility' was something that most respondents seemed to agree and be comfortable with. Evidently this could be attributed to that the conservation of a species with global appeal was being discussed. It is likely that other less known environmental resources in China would not receive such global support. Still finding an appropriation payment scheme remained problematic. The two types of payment vehicles for the provision of public goods are donation and tax schemes. Donation schemes (private provision of public goods) are more credible when funding such global public goods but are susceptible to free riding and strategic responses. Compulsory payment schemes avoid some of the strategic issues associated with donation programmes but pose serious credibility and acceptability issues when they are used to fund such non-use public goods. The end result was to choose an airport sir-charge that would be paid by all adult tourists upon departure from China. Such targeted fund raising schemes have recently become familiar amongst tourists. Yet they are mostly voluntary in nature (e.g. airlines have raised funds for various public goods or 'good causes'). However, it was feared that the symbolism attached to the Panda (e.g. it is the WWF logo) combined with the hypothetical nature of a survey would inflate warm-glow and/or embedding type responses if a donation scheme were used. Therefore, it was important to use a payment scheme that diminished such potential biases and did not make it easy for respondents to agree to paying to any scheme presented to them. Tax-schemes (i.e. public provision of public goods) implemented in each tourist's country of origin were not viewed as credible by respondents. The acceptability of such a tax scheme may have been different if the interviewing was done in the country of origin (see Swanson *et al.* (2002) Kramer and Mercer (1997) Johansson (1999) for such applications). Yet, contractual obligations required that the survey had to be implemented in China and hence the airport tax was seen as the best compromise. It would reduce the impulsive warm glow responses that would be generated from a 'panda donation appeal' but at the same time it may invoke protest responses. Note that warm glow effects can still be present under a compulsory scheme especially in the context of a hypothetical survey.

In line with the definition of wildlife value presented above, each of the three conservation scenarios was described as having a two dimensional impact on the state of the Giant Panda (compared to the current *status quo*). First, the stock of the species would be changed in that it will be increased and maintained at the MVP level and at the same time a different type of living environment would be allotted to each panda. The latter would effect the well-being of the species in two ways. First, the different living environments would allot different amounts of space to each panda. It is assumed that allocating more space per animal entails increased (albeit diminishing) animal welfare levels (as perceived by humans). Under a paternalistic altruism framework an increase in land allocated per panda would in turn increase individual utility. Secondly, the different living environments would entail a different amount of biodiversity and/or degree of wildness or naturalness. Again, this enhanced degree of wildness or naturalness may be welfare enhancing. These two last two forms of value (i.e. animal welfare and wildness value) would constitute expressions of existence value.

More specifically, individuals were informed that each Panda conservation programme being considered would increase the size of the Panda population from the current level of 200 animals to a viable population level of 500 animals. Yet, an additional qualitative dimension was also affected in each policy change. This referred to the amount of land that would be purchased and allocated to each Panda. In the first scenario a breeding programme would be developed that would conserve Pandas in captivity in standard zoo-type cages. Each panda would be allocated 100 square meters (see Figure 5.3). In total five hectares of land would be required for this programme. This scenario corresponds to the programme currently contemplated for Wolong by the organisations involved in Panda conservation. Further, it was made clear that it would not be able to re-introduce the pandas into the wild at any later time since neither the habitat would be suitable nor would the species be able to re-adapt. This clarification was made so as to avoid presenting this scenario as a possible temporary programme. Total value for this 'cage' scenario would be the value for the simultaneous

[37] It should be kept in mind that the choice of undertaking the survey in China as well as the decision to use an airport tax surcharge in essence delineates the sampling population to individuals that are likely to travel to China by plane. This is in itself a self-selected group and hence any inferences to a larger a larger population of individuals must be made with great care. The 'affected population' is of course much larger than the population of tourists.

change in both the stock, q_1, and quality, q_2, levels of the state of the Panda. If the reference level of utility is specified to be q^0 and the new level provided by the 'cage' scenario as q^1, then total WTP is given by expression in Eq. 2. Since it has been hypothesised that species quality is a function of wildlife living conditions and that this enters as a positive argument in individual utility then the 'cage' scenario would conserve the species with a minimum (if any) level of animal welfare. That is, the marginal value with respect to species quality (the term $\partial e(p,q_1,q_2,u^0)/\partial q_2$) would be close to zero or in fact may even be negative.

The second conservation scenario would conserve and maintain the same number of species (500 pandas) but would do so in pens instead of cages.[38] As in the 'cage' scenario, the species would indefinitely be preserved in captivity but now each panda would be allocated 5000 square meters (or half a hectare). This area was described as being roughly the size of a football pitch (see Figure 5.4). In total 250 hectares of land for the entire programme would be required. Considering the same reference state, q^0, and the post reference state from the 'pen' scenario as being, q^2 , the total WTP for this multi-impact scenario would be defined similarly as in Eq. 2.

The marginal value with respect to stock size would be the same as that in Eq. 2. since it is assumed that gene values are perceived to be the same under alternative quality regimes.[39] However, the value for animal welfare may be equal or larger than that in the cage scenario on account of animal welfare being a monotonically increasing argument in the individual's utility function. Hence, total WTP for the 'pen' should be equal or greater to that of the 'cage' scenario. Finally, note that this scenario provides no biodiversity benefits in that the species is simply conserved in a larger captive and artificial environment.

Finally, the third conservation scenario involved *in situ* conservation of the Panda in its natural habitat. This would require the acquisition of substantially lager amounts of land. Under this

[38] This scenario is also being perused in Chengdu and in Hong Kong but also in other countries. These programmes try to offer 'simulated' panda habitat in about 1000 sq.m. per panda.

[39] This may not be true in the long run since alternative conservation policies may take a species down different evolutionary paths. Also, even in the short term, it is conceivable that people may perceive that genes from 'free-

scenario each panda would be allocated 400 hectares (see Figure 5.5). This amounts to 200,000 hectares in total which is roughly the size of the entire Wolong reserve. Total WTP for a change from the same reference state, q^0, to the post reference, q^3, would be defined as above. Again, it is assumed that gene stock value is the same as in the previous scenarios while animal welfare or existence value should be equal or larger. However, in this scenario animal welfare or existence value does not stem from simply allocating more space to each panda as is in the 'pen' scenario but from providing the entire natural habitat (and the biodiversity wherein) to the species itself. It is contemplated that this is a form of animal welfare or existence value in that the direct 'beneficiary' is the species itself. It is postulated that human benefits from preserving biodiversity in its own right are merely incidental. Moreover, this form of value has been considered as a form of derived demand for biodiversity (e.g. Loomis and White, 1996). The emergence of this implicit or derived biodiversity value is entirely dependent on the desire to provide a natural undisturbed environment to the species itself. People may acknowledge that preserving the habitat constitutes 'value for money' in that society obtains the added benefit of conserving more species. Yet, what is important is that the source of value is the species itself and not the appeal or benefits from saving a part of nature *per se.* This form of value constitutes an addition to the values expected to arise in the 'cage' and 'pen' cases hence total WTP for the 'reserve' scenario should be equal or larger than that other two scenarios.[40]

5.5.7 Multiple Scenario Issues.

An important aspect in developing the final questionnaire format concerned how to deal with the special design issues that emerge when multiple WTP bids are elicited from the same individual.[41]

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range' as opposed to caged pandas are somehow superior. Yet, for the purposes of this study it is assumed that the gene value from all scenarios is the same.

[40] Also note that respondents were told that "... under all three scenarios it will still not be possible to visit Wolong to view Pandas". This piece of information was added so that respondents would not perceive that going from the *ex situ* to the *in situ* programme would entail loss in possible recreation benefits.

[41] First best CV practice suggests that if WTP for different programmes or for different levels of the same programme is desired then a split sample design should be used. Yet, at the same time it has been acknowledged that one of the most important challenges for CV design is how to find ways to curb the costs of undertaking the study while maintaining its credibility (Carson *et al.*, 2001). Understanding how to minimise response biases

First, the reference level of utility for each scenario had to be determined. Since the scenarios were nested there were two possibilities. One would be to ask for sequential WTP bids that would correspond to the sequence $q^0 \to q^1, q^1 \to q^2, q^2 \to q^3$ while the other would be to ask for total WTP bids that would correspond to the sequence $q^0 \to q^1, q^0 \to q^2, q^0 \to q^3$. The former approach poses a much more cognitively difficult task to respondents as well as introduces substitution and income effects as the respondent goes from one question to the other (see Randall, 1991). The latter approach avoids these problems since it presents the scenarios as mutually exclusive so that respondents are asked to provide their WTP for each programme irrespective of their response to the previous WTP. Thus, as shown in the Section 5.5.6 the latter option was chosen and the same reference level of species quantity/quality was maintained across all three scenarios. By presenting the programmes as mutually exclusive states that are to be valued using the same reference level of utility, respondents are in essence asked to re-adjust their budget constraints as they move from one question to the other. Bateman *et al* (2001a and 2001b) have labelled this the "exclusive-list" format and is to be contrasted with the "inclusive list format" which ascertains marginal (or extra) WTP values for each new scenario.

Secondly, the sequence in which scenarios were to be *presented* had to be addressed. This refers to whether descriptions of scenarios were to be presented all in advance and then WTP questions for each scenario elicited as opposed to presenting the scenarios sequentially and then eliciting WTP values as each new scenario is presented. Bateman *et al.*, (2001a and 2001b) have referred to the former approach as 'advanced disclosure' while the latter as the 'step-wise' disclosure approach. The authors point out that despite the acknowledged importance of this issue in other fields of experimental economics and game theory (e.g. Cubitt and Sugden 2001), the CV literature has mostly neglected the significance of this distinction. More specifically, recent research has found that the choice between 'advanced' and 'step-wise' disclosure may have different implications with respect to ordering biases.[42] Economic theory tells us that when operating under a (mutually) *exclusive* list format, then the

when using a multiple scenario design is thus a valuable contribution towards this end (see for example the work by Bateman *et al.*, 2001a and 2001b).

[42] See Boyle *et al.* (1993) and Carson and Mitchell (1995) for a discussion of ordering effects.

order in which the WTP is ascertained for the options of the list should not matter (Randall, 1991). Yet, empirical evidence presented in Bateman *et al.* (2001a and 2001b) suggests that ordering effects are present under a *step-wise* presentation format implying that there seems to be some other psychological processes at work that biases the results. The same body of research has found, however, that such ordering effects are insignificant under the advanced disclosure approach. Moreover, advance disclosure designs have shown to produce much more stable results in that respondents do not wish to adjust their stated bids. In contrast, empirical evidence from the same authors suggests that step-wise formats tend to induce respondents to want to change their initial bids as more goods are progressively added to the visible choice set.[43] Finally, the results of Bateman *et al.* (2001a and 2001b) unequivocally show that the advance disclosure design produces more consistent results in terms of the observed degree of scope sensitivity of WTP values. Taken together these findings justify the use of the advanced disclosure format in the current study. Finally, since the advanced disclosure format has been found not to lead to significant ordering effects it was immaterial whether the WTP questions were asked in a 'bottom-top' or 'top-bottom' manner. The current paper employed the former order of presentation.

[43] Bateman *et al.* (2001a) have attributed this to "surprise" resentment.

5.5.8 Embedding and WTP for wildlife conservation.

The survey design also addressed potential embedding biases that may result when valuing such public goods. The term 'embedding' in the valuation literature has acquired an elusive connotation in the past two decades incorporating various types of biases or anomalies and meaning different things to different researchers.[44] In the current context embedding refers to the danger that the respondents are valuing a larger good than that which the researcher intended. This invalidates the usefulness of the results since the researcher cannot know which part of the estimated benefits reflect the species being conserved and which are related to 'something else'. Embedding bias may be a particular problem when valuing charismatic and high profile species because of the emotive and symbolic characteristics with which they are associated. In this CV study there were three types of embedding that seemed to be potentially troublesome.

First, individuals may be providing a value for "saving all species" or "all environmental resources" rather than just the panda. To some degree the effects from this form of embedding can be minimised by adequate survey design and appropriate information provision (Carson *et al.* 2001).[45] Yet, survey design cannot be infallible and thus internal tests may be used to examine its presence. In our case, one indication that the elicited values are not bids for all environmental causes would be provided if the values were observed to be sensitive to the amount of land associated with each conservation programme. This in essence amounts to an internal scope test (Bateman *et al.,* 2001a and 2001b).

Second, some economists have argued that stated values for wildlife conservation are nothing but mere expressions of one's environmental or other social attitudes and not expressions of his/her Hicksian consumer surplus. (see Blamey, 1998; Rekola *et al.*, 2001; Opaluch and

[44] For a discussion of embedding with different interpretations and in different contexts see Carson *et al.* (2001), Schulze, *et al.* (1998), Randall and Hoehn. (1996), Mitchell and Carson (1995), Loomis *et al.* (1993), Fischhoff *et al.* (1993), and Kahneman and Knetsch (1992).

[45] This included adequate description of the scope of the good being valued as well as reminding participants that their responses should take account of their budget constraints as well as other possible substitute goods.

Grigalunas, 1992). This criticism is included as a form of embedding since it implies that individuals are providing a much wider expression of their preferences than is requested by the CV exercise. The presence of this form of embedding is assessed by examining whether the elicited values can be explained by a series of socio-economic variables in a manner that suggests that they are not mere expressions of general attitudes but are consistent with economic models of behaviour.[46]

The last form of potential embedding is most common in studies that value the conservation of a species in its natural habitat. The embedding effect emerges because individuals may be valuing the benefit from preserving the entire ecosystem as such as opposed to the benefits from a single species. In our case, this form of embedding is relevant only for the third valuation scenario. The danger here lies in that any WTP stated in excess of that offered for the 'cage' and 'pen' scenarios may not be attributed to animal welfare or existence value (which is the hypothesis of the study) but to the benefits from preserving the ecosystem or habitat itself *irrespective of its relationship to the particular species.* Again, under this form of embedding the individuals would be providing values that would be associated with a much larger good.

Moreover, the consequences of paying and not paying were made explicit. These design elements attempted to make the trade-off between income and the change in the level of the specific public good as realistic as possible.

[46] This form of embedding is linked to so called warm glow values. Some CV practitioners have argued that the literature on the effects of the warm glow on the validity of CV estimates (e.g. Kahneman and Knetsch, 1992) is mostly confused and irrelevant. This is so, since the introduction of the warm glow into microeconomic models of behaviour was developed in response to difficulties in explaining phenomena occurring in cases where public goods were *privately* provided (e.g. via donations) but were publicly consumed (e.g. the work by Andreoni, 1990). Yet, the public goods that are being valued in most CV applications are usually *publicly* provided (e.g. via compulsory taxation) and publicly 'consumed' (Carson *et al.*, 2000)). It is, thus, concluded that warm glow benefits should not pose a problem for a properly designed CV study since they would be incompatible with a compulsory increase in taxes. However, warm-glow type effects may still be present in well designed stated preference studies even if the good is to be publicly provided (say via taxation). These effects may arise out of the sheer hypothetical, non-binding and indecisive nature of the CV exercise (see Carson *et al.*, 2000; Chilton and Hutchinson, 1999; Blamey, 1998; Champ *et al.*, 1997; Kahneman and Knetsch, 1992). The presence of this form of warm glow can seriously discredit the estimated results since it will indicate that the values are not related to the good being valued but are linked to some other motivation which in turn is linked to the hypothetical nature of the CV exercise. The purpose of a CV study is not to estimate peoples' instantaneous welfare *from responding to CV questions*, but rather to see the responses as valid also *outside* the survey context. And if moral satisfaction or expressive value occurs when responding to the CV questions, all other people who are not part of the sample would clearly not receive this welfare (Johansson, 2002). Hence the presence of warm glow is particularly damaging if we want to make any inferences on WTP beyond the sample.

It was argued above that the valuation of certain 'charismatic' species may often include implicit valuation for the components of the ecosystem that supports these high-profile species (Loomis and White, 1996). What is crucial for the credibility of the results from single species CV studies is that the *all habitat values stem from and are specific to the species being valued.* This would be the case when habitat *per se* is perceived as having many close substitutes and little value on its own. In this case habitat would only have value when associated with a charismatic endangered species with very few perceived substitutes.[47]

Both the focus groups and the pilot study suggested that in, contrast to the Giant Panda, people did not perceive China's natural environment in general as a global public good.[48] Still, the danger of this form of embedding remained and in order to minimise its effects respondents were informed that though the mountainous regions of the Sichuan host many plant, animal and bird species, none of these were 'rare' or under threat of extinction. This implied that the habitat when not providing a home to the panda had many close substitutes in China and abroad. Finally, an auxiliary scenario was presented after the values of the three main conservation programmes had been elicited that tried to obtain an additional indication of whether this form of embedding effect was at play. Respondents were asked to state their WTP for the preservation of the Wolong Reserve but were told that the authorities could only guarantee with certainty the conservation of only 300 (and not 500) pandas. Hence, the long-run conservation of the panda was described as being highly uncertain.[49] Yet, individuals were told that the remaining flora and fauna would be preserved. In essence, this scenario offered to conserve the reserve but with a very low probability that the species will be saved. No doubt, this scenario has some credibility issues and other design flaws.[50] Yet, it does

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[47] It is becoming increasingly apparent that in many cases single species valuation may not make much sense and segregating species from habitat values may not be possible. (e.g. Loomis and White, 1996; Fredman, 1996). Yet, single species studies are often relevant as is the case with many 'charismatic megavertabrates' and thus it is crucial for the credibility of the results to ensure that the estimated values are specific to the species being valued.

[48] Common responses on this point from the focus groups and pilots were of the form "we have our own forests to worry about" or "this is China's problem."

[49] The term "highly unlikely" was used to convey the idea of low probability of survival associated with conserving 300 instead of 500 pandas.

[50] For example, individuals may be confused as to why the authorities could not guarantee panda conservation when in the previous scenarios they were told that this would be the case. Also, the scenario was not included in the presentation of all the visible choice set in the advance warning design. This may be a source of further noise in the results.

provide an indication of whether the Wolong reserve has any public good value when it does not provide habitat to the Panda.

5.6. Sample characteristics

A final sample of 23 tour groups was selected providing 305 useable completed surveys. Three stratification variables were used for sampling the groups, namely nationality, expected income and expected age of the group. This information was provided by the CITS based on previous market research and from personal experience. The sampling strategy proved to be very successful indeed with an average within group response rate of 70%. Moreover, Table 5.3 shows that the mean values of the variables used for sample stratification (as provided by CITS) were very close to the corresponding figures obtained in the sample. The sample exhibits some under-representation of Asians. This was due to difficulties in undertaking the survey in a language other than English, German or French. Also, the year the survey was conducted (1998) most of East Asia experienced a harsh financial crisis which considerably reduced the overall number of Asian tourists visiting China that year. (see Swanson *et al.*, 1999 for full details of sampling strategy).

Table 5.3 reports the socio-economic profile of the sample. Most of the sample fell in the age range of forty through seventy years old. There is large percentage of people with a university degree (71.4%) and the average income is relatively high at US$4350, but this is to be expected since China generally attracts upper market non-mass tourism. Moreover, most respondents were visiting China on a package tour of about two weeks' duration. The average cost of such a holiday was about USD 3600. Over 80% were making their first visit to China, and 40% reported that they were likely to visit China again in the future.

Overall the survey instrument appeared to work quite well in the field with 55.8% of the sample finding the survey interesting and only 6.5% of the respondents finding the questions difficult to understand. Only a very small proportion of the surveyed group seemed to object strongly to its presentation (0.7% bored) (see Table 5.5).

5.7. Summary statistics of WTP bids

Table 5.6 provides sample summary statistics of the three stated WTP distributions while Figure 5.6 provide their visual representation. The sample means and median values are increasing in the direction in which scenarios are nested (bottom-top) with mean (median) values of US$3.9 (US$1), US$8.4 (US$5) and US$14.8 (US$10) respectively. Moreover, examining the three WTP responses of *each individual* it can be shown that all participants responded to all three WTP questions in the predicted direction with no respondent expressing a larger WTP value for a good further down in the nested sequence. This confirms the findings from the focus groups and pre-tests that increases in land allocated to a species (keeping species population constant) is viewed as welfare enhancing.

Moreover, all three WTP distributions exhibit the commonly observed shape, with a large mass at low figures and a long tail (see Figure 5.7). The range of the tails is US$30, US$75 and US$100 respectively. Further, we see that the percentage of zero responses substantially decreases (from 37% to 7%) as we move from the 'cage' to the 'reserve' scenario. Since, all design aspects (such as the payment vehicle) remained constant across scenarios it can be inferred that the decline in the proportion of zero responses is due to increases in the amount of land provided to the species. This suggests that most respondents perceived the scenarios as credible and responded in accordance to their preferences for the benefits entailed in each programme and not in reaction to some design attribute. Zero responses are of a particular problem in WTP data when they are considered to be forms of protest to some aspect of the scenario or programme. Accounting for different types of zero responses in parametric econometric models was addressed in the previous chapter.

5.8. Implied Preference Ordering of Scenarios

It is interesting to examine the implied preference orderings of the three scenarios. Table 5.7 summarises the various combinations of stated bid sequences observed in the sample and the corresponding implied preference orderings.[51] In total seven different types of orderings were observed. [52] Only 7% of the sample expressed a zero WTP for all three scenarios. Assuming for the moment that these responses do not reflect 'protest bids', then they can be interpreted as representing individuals that are indifferent between saving and not saving Pandas for all proposed levels of animal welfare (i.e. $q^0 \sim q^1 \sim q^2 \sim q^3$). The low number of such responses (despite the unpopular payment vehicle used) signifies the popularity of the Panda.

The majority of the sample (65.25%) expressed a strict preference for the reserve scenario (i.e. $q^0, q^1, q^2 \prec q^3$). Yet, interestingly only about 31% revealed *strictly increasing* WTP responses across all nested programmes (i.e. $q^0 \prec q^1 \prec q^2 \prec q^3$). About 15% of the sample were in favour of conserving the panda population but were indifferent over the means this will be achieved (i.e. $q^0 \prec q^1 \sim q^2 \sim q^3$). About 12% favoured panda conservation in 'pens' over 'cages' but were indifferent between conservation in 'pens' and the 'reserve' (i.e. $q^0 \prec q^1 \prec q^2 \sim q^3$) while 4% were indifferent between the 'cages' and 'pens' scenarios but strictly preferred the 'reserve' scenario (i.e. $q^0 \prec q^1 \sim q^2 \prec q^3$).[53]

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[51] The preference orderings are 'implied' or 'inferred' since individual were not explicitly asked to rank or order the options but simply asked to provide three separate WTP responses. Yet, these responses can be used to infer the preference ordering. Under an exclusive list format both explicit and inferred preference orderings should be the same (see Bateman *et al.*, 2001a and 2001b).

[52] There are eight possible responses that are compatible with the bottom-top nesting design of this experiment. The ordering. $q^0 \sim q^1 < q^2 \sim q^3$ was not observed. Also note that since the 'goods' were designed to be nested in a unidirectional bottom-top manner it was not expected to observe an individual who would reveal an ordering such that a good higher up the sequence would be values less the one lower down the sequence.

[53] A zero marginal WTP between two adjacent programmes implies that the individual is indifferent between programmes. This could be explained by various reasons. For example, certain individuals when faced with current prices and income may not be willing to pay for any additional increments in the public good. Also based on individual taste variables that characterise the nature and shape of their utility function the individual may experience satiation for certain levels of the public good (e.g. Lancaster, 1971, Rollins and Lyke, 1998). That is, it is reasonable to expect that most individuals would prefer the 'reserve' programme but not all individuals would be willing to pay an extra amount over and above what they would pay for, say, the 'pen' scenario. Also, note that in other experimental settings researchers interpret expressed indifference between two goods A and B as a case

Finally, approximately 12% of the sample stated a zero (total) amount for the first scenario *and yet* they stated positive (total) WTP amounts for the subsequent two scenarios. Similarly, about 17% of the sample provided zero WTP values for the first two scenarios but then stated a positive amount for the 'reserve scenario. These responses suggest that the individual would prefer not to have pandas conserved at all if this were to be done in captivity. Put differently these responses reflect individuals that are indifferent between saving and not the saving the panda under the first two scenarios but would nevertheless prefer conservation over extinction under the third scenario (i.e. $q^0 \sim q^1 \sim q^2 \prec q^3$). It appears that these individuals (comprising 30% of the sample) receive such a strong disutility from programmes involving captive breeding of animals that *total* value for such scenarios is driven to (or below) zero. In terms of the model of total value expressed in Eq. 2 it appears that the term $\partial e(p, q_1, q_2, u^0)/\partial q_2$ is negative and larger than the positive term $\partial e(p, q_1, q_2, u^0)/\partial q_1$).

5.9. WTP for panda conservation as a function of land

The results thus far show that there is a strict preference for purchasing the property rights for additional amounts of panda habitat, in that the elicited amounts for the three programmes increased in respect to the land area offered. Further, a Mann-Whitney test confirms that the differences between the elicited values for Panda conservation are different from zero, which implies that values are scope sensitive with respect to changes in the amount of land provided to each panda (see Table 5.8).[54] Moreover, it can also be seen that not only are values exhibiting statistically significant increases in the desired direction, but they are also exhibiting diminishing returns with respect to land provided to each Panda. Using sample means of total values we see that marginal WTP for the first 5 hectares associated with the

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of 'censored preferences', i.e. the individual *does* have a strict preference either A>B or B>A but for some reason it is not revealed (see Layton *et al.* 1999). This is not the case here since indifference is interpreted as the result of satiation.

[54] The Anderson-Darling tests rejected that the WTP distributions are normally distributed and hence non-parametric tests of significance were employed. The Mann-Whitney test rejects the null of WTP=0 at the 1% significance level in all cases.

'cage' scenarios is \$0.72/hectare.[55] The marginal WTP for the additional 200 hectares required for the 'pen' scenario is \$0.002/hectare while the marginal WTP for the additional hectares (199750) required for the 'reserve' scenario is \$0.000054/hectare.

Further the functional relationship between the WTP for panda conservation and additional levels of land was estimated using a stacked regression model. This would model WTP for panda conservation as a function of different amounts of land as well other individual-specific variables. The model (through simulations) also allows for the estimation of marginal WTP values for a larger span of land values. This functional relationship can be used by policy makers to assess the net benefit of conserving the marginal hectare of land.[56]

A random effects Tobit is the appropriate specification since this accounted for (a) potential censoring at zero (Donaldson *et al.*, 2000) and (b) possible correlation across the three WTP responses (since they come from the same individual) (Greene, 1990; Madalla, 1987). Further, Madalla (1987) shows that in such stacked data models the coefficients on the influence of an individual's personal characteristics on WTP responses can only be identified with a random (and not fixed) effects model. The random effects model includes a random disturbance that is common to and constant over a given individual's responses and assumed to be uncorrelated with the other regressors (Madalla, 1987) as well as a transitory error due to random response shocks across individuals (Alberini *et al.*, 1994). Similar models have been used by Bateman and Jones (2003) and Bateman *et al.*, (2001), Larson and Loomis (1994), Loomis and Caban (1998) and Payne *et al* (2000).

The results of this model are presented in Table 5.9. Only the best-fit and most parsimonious model is presented. The variable on 'land' enters the set of regressors in logarithmic form since economic theory suggests diminishing marginal values with respect to habitat (e.g. Mäler, 1974; Hoehn, 1991). The explanation of the regressors is offered in Table 5.14. The co-efficient results all have the expected sign. More importantly, the parameter on land is positive and highly significant. Finally, Table 5.10 and Figure 5.8 show simulated marginal

[55] In line with Rollins and Lyke (1998) marginal WTP values are calculated as difference in value between programmes divided by the difference in hectares implied by the programmes.

values for different levels of lands provided as panda habitat. The graph clearly shows the pattern of increasing but diminishing values.

[56] A similar functional relationship has been estimated by Loomis and Caban (1998) for the case of the spotted owl habitat.

In sum, these general results from the study demonstrate that there is a significant and logically consistent WTP for "panda habitat". The interest in the charismatic species translates into a WTP for the lands on which it naturally resides. The existence of such a demand should enable policy makers to purchase the property rights to some of these lands for the purpose of providing a natural quality of life for the endangered species. In short, there is a demonstrable WTP for property rights for the panda.

5.10. Decomposing Values

Our more substantial enquiry in this paper concerns the nature of this WTP for panda habitat. Does it exist as a distinct and separable value from the value of the giant panda itself? Is the charismatic species a necessary instrument for the value to exist? We now pursue these issues in a series of analyses concerning the decomposition of the WTP for the Giant Panda in this study.

As mentioned in Section 5.5, we developed this part of the study by means of modelling the panda as a multifaceted good, comprising both quantity and quality aspects. Further, we have argued that different aspects of the species may give rise to different forms of values. We referred to the benefits associated with purely quantitative aspects of the panda (its stock) as the "gene flow" benefits from conserving the species. We referred to the benefits from purely qualitative aspects of the species (its quality of life) as the "existence value" benefits from the conservation species consisting of animal welfare and implicit biodiversity values.

It has been the hypothesis throughout the chapter that the WTP for the 'cage' scenario would capture the value respondents place on the gene flow benefits from panda conservation.[57] The WTP for panda gene preservation was found to have a mean value of US$3.9 while its median dropped to US$1. Further, it has been hypothesised that the WTP values for the 'pen' and 'reserve' scenarios would represent both gene flow *and* different levels of animal welfare values. Since the level of gene flow value is assumed to remain constant across all

[57] Some minimum level of animal welfare value could still be present even in the cage scenario. This would be justified in the lines argued in Blackorby and Donaldson (1992) and Cowen (2001).

programmes, the difference between scenarios would provide an estimate of the magnitude of different levels of animal welfare value. Taking the difference between the three WTP distributions will produce *inferred* welfare measures:

$$WTP_{pen-cage} = WTP_{pen} - WTP_{cage} \qquad \text{Eq. 3}$$

$$WTP_{reserve-pen} = WTP_{reserve} - WTP_{pen} \qquad \text{Eq. 4}$$

$$WTP_{reserve-cage} = WTP_{reserve} - WTP_{cage} \qquad \text{Eq. 5}$$

Eq. 3 provides the additional WTP for removing Pandas from the breeding centre with cages to one where animals are kept in pens. This value is US$4.53 and represents the value individuals would be willing to pay to purchase 200 additional hectares of land for the benefit of the species itself. This extra land would have no contribution to the genetic survival of the species nor to overall biodiversity preservation but would simply enhance the welfare of the Panda. This form of animal welfare value constitutes 54% of the total bid for the 'pen' scenario. Eq. 4 provides the additional WTP for removing Pandas from the pen-based breeding centre and purchasing the land required for an *in situ* conservation programme. This value is US$6.43 and is the value associated with buying 199750 extra hectares of land, in order to move to a "natural" quality of life for the species. This value has been interpreted as a form of implicit valuation of "natural habitat" and it constitutes 43% of the total bid.

If we consider the gene flow value to be a use value, then total existence value (animal welfare and implicit biodiversity value) associated with the 'reserve' scenario (Eq. 5) is then US$10.96 which constitutes 73% of the total stated bid. Such a high figure for the proportion of existence value in the 'reserve' scenario is in line with other attempts to decompose values for *in situ* wildlife conservation using the percentage split approaches described above (e.g. see Langford *et al.*, 2001).

Our decomposition of the WTP for the giant panda demonstrates that the panda's flagship status translates into substantial WTP for natural habitat. Figure 5.9 summarises the decomposition of NUVs for the Giant Panda. The charismatic species generates interests in its genetic existence and its individual welfare, but this represents only about half of the total WTP for the species. There is an increase in the WTP for the species from USD 8.43 to USD 14.86, generated by the provision of a "natural" quality of life. This represents 43 per cent. of the total WTP for the charismatic species. This is value associated with the panda that is available to nature conservation for *in situ* conservation, but is unavailable when *ex situ* is elected. Clearly, the giant panda might be used as an important instrument for general nature conservation purposes.

5.11. WTP for in situ Panda conservation when long term survival is not certain

The final issue of interest was the extent to which the giant panda is a necessary instrument for the conservation of nature. That is, if the panda is not used to conserve its habitat, then would an independent WTP exist to provide for the conservation of these lands? This is important for the purpose of determining the extent to which the construct of charismatic species has substituted for the general motivation to provide for the conservation of nature, and it addresses directly the question of the extent to which *ex situ* conservation is a substitute for or a complement of *in situ* conservation.

We examined these questions in the context of a final part of the panda survey. As mentioned in Section 5.5.8, an auxiliary scenario was presented after the values of the three main conservation programmes had been elicited that tried to obtain an indication of whether individuals valued the Wolong reserve independently from its function as Panda habitat. Table 12 presents the summary statistics from this WTP question. As can be seen the sample overwhelmingly stated a zero WTP for a conservation programme that (although securing the preservation of the Wolong reserve), did not guarantee the conservation of the Panda. Using a Mann-Whitney test we can reject (at the 0.5% level) the null hypotheses that the mean WTP values for *in situ* conservation with and without preserving the MVP of pandas are equal.[58]

[58] Admittedly, the scenario suffers from credibility issues. It is possible that individuals are rejecting a scenario inconsistent with those provided earlier in the survey.

Thus, the WTP for the giant panda is not only a potential instrument for nature conservation, it is potentially a necessary instrument for nature conservation. Once having created the construct of charismatic species, it is the continuing existence of such constructs that drives the WTP of the public for nature in general. Finally, these findings brings into question appeals for appropriating existence values made by numerous conservation *fora* in order to pursue *ex situ* wildlife conservation programmes.

5.12. Assessing determinants of WTP for component values

The above inferred distributions for gene, pure animal welfare and implicit biodiversity values were subjected to multivariate regression analysis. Investigation of the determinants of the elicited WTP values provides further insights as to the nature of these values. Moreover parametric regression results provide an indication of the degree to which the measured values are expression of consistent (economic) preferences and are not simply random responses or expressions of general attitudes and beliefs. This offers additional internal (construct) validation of CV results (Mitchell and Carson, 1989, p.206; Arrow *et al.* 1993).

5.12.1 Independent Variables.

The independent variables that were used for the regression analysis are described in more detail in Table 5.14. The variables include commonly used socio-economic variables such as income, sex and age. Also, an index of the subjective rating of the credibility of the panda conservation programmes ('programme index') was constructed as well as a series of four motivation indexes. The table also includes a series of motivational indexes. These are of little use when the aim is to make out of sample predictions of expected conditional WTP or to construct a benefits transfer function.[59] Yet, the use of motivational indexes is of particular importance when examining the nature and internal validity of CV results.

The first of these four indexes was constructed by *directly* asking people for the reasons they may value panda conservation. Using these responses an index was constructed that provided a measure of the *relative* importance that individuals place on instrumental (or use) reasons for conserving the Panda versus non-instrumental (or non-use) motives. For this reason it is labelled as "Use/non-use" index.[60] The other three motivational indexes were constructed with the aid of factor analysis.[61]

The aim of the factor analysis in this study was to reveal indicators of latent factors that are associated with existence values. These have been argued as being related to altruistic, stewardship, ethical and empathy motives. A series of attitudinal and behavioural questions were asked prior to the WTP questions that would be potential indicators of such latent motives.[62] All questions were coded using a 1 to 5 Likert scale. No *a priori* hypothesis was made as to which variables would constitute a factor. Hence, so called 'exploratory' factor-analysis was used. The analysis was undertaken in STATA 6 using the principal factor extraction method. Factors with an eigenvalue above one where retained. Varimax rotation suggested the existence of three factors. Results are presented in Table 5.13. The indexes were named on the basis of the variables that 'factored' together as well as the relative magnitude of the factor loadings.[63] The first factor consisted of variables that could be easily associated with various motives. A high score in this factor would be associated with an individual who would not desire excess or unnecessary harm caused to animals. Yet, these individuals would be willing to accept the use of animals for medical purposes and they do not have strong views or preferences in favour of 'animal friendly' food production processes. Moreover this factor could also be associated with people who desire to be perceived as doing

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[59] This is so because data for attitudinal variables are absent for out of sample individuals.

[60] Respondents were provided with a series of reasons for the conservation the Giant panda that ranged from highly instrumentalists (e.g. "Loss of genetic material probably useful in the future") to non-instrumentalist (e.g. "Pandas have a right to survive"). The order of the statements was mixed and individuals were asked to choose *up to three* of their most important reasons. An open-ended option was also included. Open-ended responses were classified on the basis of their proximity to one of the predetermined reasons in the list. Each response received a score from zero (for very instrumentalists) to five (for very non-instrumentalists). An index was then obtained by dividing the sum of the scores by the number of responses provided by each individual (at most three). This provided a measure of the *relative* importance that individuals placed on instrumental versus non-instrumental motives for conserving the Panda.

[61] Some of the rare applications of factor analysis in stated preference studies can be found in Boxall and Adamowicz (1999), Nunes and Schokkaert (2002), Langford *et al.* (2001), Karppinen (2000), Whitehead and Thompson (1993), and Jorgensen *et al.* (2001). As explained in Chapter 3 the use of latent constructs in econometric analysis of choice has received much attention by leading micro-econometricians and consist a fruitful course for future research.

[62] The questions were chosen on the basis of Bartholomew (1987) and Schilderinck (1978).

[63] The second and third factors only consist of two variables. In some cases this may be indicative of a spurious factor. Yet in out case the eigenvalues are above 1 and the factor loadings are very high which provides confidence that these can be considered as legitimate factors.

the 'right thing' (demonstrating) or as belong to a group with particular shared social or ecological values (group membership or identification). This general index was labelled as "animal welfare index". The two variables that loaded into the second factor signify a substantially different latent variable than that implied by 'factor 1'. This factor includes individuals who are more likely to be strict vegetarians *as well as* people who would be against the use of animals even for medical experiments. Hence, this factor could signify some latent animal rights or objectivist-type of environmental ethic. For brevity factor 2 was labelled as 'ethics index'. Lastly, the variables that loaded into the third factor suggest affection or empathy towards animals (e.g. pet ownership received the highest factor loading). This factor was labelled as 'sympathy' index'.

5.12.2 Econometric Specification and Results

As explained in Chapter Four the data generating process of this experiment as well as the limited or censored nature of the elicited WTP distributions required that variants of limited dependent variable (LDV) models were employed. Only the 'best fit' models for each distribution are presented and only sign and significance of the estimated parameters of the explanatory variables are discussed since this is most relevant in examining construct validity. For ease of comparison the same set of explanatory variables are used in all models.

The responses to the WTP question for the 'cage' scenario are best described by a mixture discrete/continuous distribution model. In these mixture models the individual is assumed to be making two decisions. The first concerns a discrete (binary) 'participation' decision that dictates whether the individual will be recorded as having a zero or non-zero WTP. A recorded zero WTP would imply that the individual is indifferent between the reference and post-reference state of the public good. In this study a zero would be recorded if the individual does not care about panda conservation, perceives that they cannot afford to pay anything or mis-reports his/her true value (a form of protesting). The second part of the mixture model accounts for the WTP or payment decision. This would be the decision over how much to contribute to each programme (given that it were the only programme available). The general statistical structure of these mixture models can be explained by a behavioural model of discrete random preference regimes (Pudney, 1989). Under such a model the participation decision is more likely to be explained by motivational and latent taste variables while the payment decision is expected to be affected by taste *and* socioeconomic variables such as income, sex and age. The specific type of mixture models characterising the WTP for 'cage' scenario is the double hurdle or bivariate Tobit model.

In contrast, the distribution for the inferred distributions from the differences in WTP *between* scenarios are best described by *univariate* Tobit models. The behavioural model underlying the Tobit structure suggests that the participation and payment decisions are dictated by the same latent variable and thus, they do not constitute separate decisions.

Table 5.15 present the regression results of the LDV models for three WTP distributions on gene, animal welfare and biodiversity value respectively. In both the bivariate and univariate models diagnostic testing for normality suggested that transformation of the dependent variable was required. Here we present the results from an inverse hyperbolic sine transformation.[64] Moreover, diagnostic testing for the presence of heteroskedastcity suggested that the variance term, σ, must be parameterised (Madalla, 1987; Yen and Jones, 1997).

Looking at the results from the 'payment panel' we see that instrumental motives are associated with higher values for gene flow values while non-instrumental values explain WTP for animal welfare and implicit biodiversity values. In fact this effect is increasing as captured by the rise in the (absolute) value of the parameter and its significance. It is also interesting that the coefficients of 'ethics' and 'sympathy' are negative for the gene value but are positive for animal welfare value. They are not significant for the biodiversity value. Clearly, these different subcategories of values are very different from one another, and are driven by very different motivations.

[64] See previous chapter for rationale behind using this transformation.

5.13. Explaining Implied Preference Orderings

Finally, the information contained in the implied preference ordering of each individual (see Table 5.7) can be used to further investigate the consistency and validity of the stated responses. In contrast to the previous section, the point of interest here is not to examine what explains one's stated WTP amount for each scenario. Instead, the focus is on examining the *added* information contained in the three WTP responses *as a whole*. More specifically, this section examines the degree to which the implicit ranking of the three scenarios provided by each individual can be adequately explained by socio-economic and motivational factors. Investigation of this relationship would further substantiated the construct validity of the results since it would indicate that stated preference orderings over alternative conservation programmes are not made in a random or haphazard manner but are consistent with and can be explained by separately measured economic and motivational characteristics.

A multinomial logit model was used to examine the effects of socio-economic and motivation indexes on the likelihood of an individual belonging to a group with a particular preference ordering. To simplify the model the seven groups of respondents in Table 5.7. were reduced to five by merging the groups '4' and '5' as well as groups '6' and '7'. Each of the five groups implied a distinctively different preference ordering. The first group of individuals chose to state a zero WTP for all scenarios signifying that they do not care about Panda conservation. The preferences of the second group suggests that it consists of individuals that care about preserving the genetic stock of the Panda but are indifferent over providing enhanced levels of animal welfare to the species. The implied preference ordering of the third group would be compatible with individuals that care about preserving the genetic stock of pandas in pens but would not be willing to pay anything extra for preserving species in their natural environment. Hence, these individuals seem to be indifferent over higher levels of animal welfare (or, put differently, are experiencing diminishing marginal utility for high levels of animal welfare). The responses from the fourth group of individuals imply that they *strictly* prefer *in situ* conservation of pandas over all other scenarios. Finally, the preferences of the fifth group also exhibit strict preference for the reserve scenario but differ from the fourth group in an important respect. These individuals stated a zero total WTP value for the 'cage' scenario, *even if this were the only scenario available for the conservation of the Panda.*[65] In this respect, this group appears to have even stronger preferences for *in situ* conservation in that they would prefer the species to go extinct if it were to be conserved in cages.

A standard multinomial logit was model was used with 'group 1' as the base category required for the Theil normalisation of the model. The four motivational indexes as well as income and the 'programme index' were used as regressors.[66, 67] The specification of the model is:

$$\Pr(y = m / \mathbf{x}) = \frac{e^{\mathbf{x}\beta_{m/b}}}{\sum_{j=1}^{J} e^{\mathbf{x}\beta_{j/b}}} \qquad \text{Eq. 6}$$

where y denotes group membership such that $y = 1...m...J$, x is a 1xk vector of explanatory variables and b is the base category or comparison group such that $\beta_{b/b} = 0$. In our case $J=5$. Estimated coefficient results are presented in Table 5.16. The raw coefficients of the multinomial models are not in themselves of particular use since they provided a very distorted picture of the effect of a change in x_k on the likelihood of producing a specific preference ordering. In fact the estimated coefficients may not even have the same sign as the true marginal effects (Greene, 1997). A more useful indication of the consistency of the reported preference patterns across groups can be obtained by examination of the true marginal effect of a change in x_k on the probability that an individual belongs to a specific group. This is provide by the expression:

[65] This follows from the advanced warning exclusive list design adopted in this study.
[66] All other variables such as age and sex were excluded for simplicity. Including these variables did not in any way alter the results reported here.
[67] The fixed choice set is the total possible orderings observed. Since not all orderings were observed certain choices were eliminated. Also note that the model has not been stated in random utility terms. Instead it should be seen as founded on purely statistical grounds. This is compatible with the motivation for using the model, namely as a consistency check. Also, the usual caveats for the use of multinomial logit are acknowledged (e.g. IIA assumptions, linear utility indirect function etc.). Yet, these need not be of much concern here since the model is used as in indicator of consistency rather as a means of predicting probabilities.

$$\frac{\partial \Pr(y=m/\mathbf{x})}{\partial x_k} = \Pr(y=m/\mathbf{x}) \cdot \left[\beta_{k,m/J} - \sum_{j=1}^{J} \beta_{k,j/J} \cdot \Pr(y=j/\mathbf{x}) \right] \qquad \text{Eq. 7}$$

Standard errors for the marginal effects were estimated using the delta method as suggested by Greene (1997, p. 916). Estimated marginal effects (evaluated at sample means for $\forall x_k$) are presented in Table 5.17. The results do provide an indication that belonging to a group with stronger preferences for *in situ* conservation can be explained by higher scores in the animal welfare, sympathy and ethical indexes.

Though these single point estimates of marginal effects are more informative than the raw parameter coefficients, they still cannot provide a clear and an adequate picture of which variables and in what manner explain individual preference orderings of the various conservation scenarios. This is so because Eq. 7 combines all of the $\beta_{k,m/J}$'s and hence the value of the marginal effects depends on the levels of all variables in the model. Further, as the value of x_k changes the sign of the marginal effect can change. A more indicative and transparent assessment of how individual taste and demographic variables affect preference orderings can be obtained by plotting the estimated conditional probabilities of observing a particular preference ordering against the regressors used in the multinomial model. Such plots would indicate the levels of each explanatory variable that maximise the likelihood of observing a particular preference ordering. The plots for the explanatory variables used in running Eq. 6 are presented in Figure 5.10 The vertical axis of each graph depicts the estimated (summary) probability of observing a particular preference ordering while the horizontal access measures taste and demographic variables (on their corresponding scales). The preference ordering ($y=1...J$) is denoted on the upper-left corner of each graph.

Notice first how these graphs make clear why the point estimates of the marginal effects may lead to deceptive conclusions since the direction (sign) of the relationship between estimated probability and explanatory variables is non-constant. More importantly the results of the graphs provide clear and unequivocal indication that the preference orderings provided by respondents are entirely consistent with the model of existence value presented in Section 0.

Examining first the effects of the 'use/non-use' index on the likelihood of observing a particular preference ordering it can be seen that the likelihood of being indifferent over the means of conservation is maximised at high 'use-motive' scores. That is, individuals who would be willing to support *ex situ* conservation of panda stocks but are indifferent over enhanced levels of panda welfare are associated with higher use (relative to non-use) motives for conserving the species (see second graph of panel A). The direct opposite is the case for individuals who exhibited a strict preference for *in situ* conservation. Here, higher non-use (relative to use) motives are associated with the highest likelihood of having a *strict* preference for *in situ* conservation. Further, individuals with mixed use/non-use motives (indicated by a middle ground score in that index) were more likely to be observed as being indifferent between the animal welfare provided by the 'pen' and 'reserve' scenario (see the third graph of panel A).

The 'animal welfare', and 'sympathy' indexes provided a similar pattern and are thus jointly presented. The likelihood of being indifferent between different levels of animal welfare is at its peak for low levels of these indexes. That is individuals who value the conservation of panda stock but do not care about the welfare of the species are found to have low 'animal welfare', and wildlife 'sympathy' scores (see the second graph in Panel B and C). In contrast individuals who are more likely to have a strict preference for the 'reserve' scenario are associated with higher scores in these motivational indexes (see the fourth graph in Panel B and C). Moreover, individuals who strictly preferred *in situ* conservation but provided a zero WTP for the cage scenario are found to be associated with even higher scores in these variables (see the fifth graph in Panel B and C). Individual's who are indifferent between the 'pen' and the 'reserve' scenario are found to have middle range scores in these indexes (see the third graph in Panel B and C)

The 'ethics' index shows a somewhat different effect on the observance of a particular preference ordering (see Panel D). It appears that high scores in the ethics index are mainly associated with a higher likelihood of observing preference orderings that would *not* support *ex situ* conservation even if it were the only conservation means available. The likelihood of observing all other type of individuals (even those who strictly prefer the reserve scenario but would be willing to support *ex situ* conservation) is maximised for lower scores in the 'ethical' index. Hence, stronger ethical concerns such as animal rights concerns would mainly be associated with a very self-selected and particular group of individuals. Yet, are such preferences merely the outcome of 'cheap talk'? The panel depicting the effect of income on the probability of observing a particular preference ordering (Panel E) suggests that the observance of this particular group is associated with relatively high income levels. It appears that forms of *ex situ* conservation enter the utility function of this group as a 'public bad'. The same panel further reveals that the probability of observing an individual who does not care about panda conservation (group one) is in fact explained by lower levels of income while the same is also true for observing individuals that are indifferent over panda welfare levels but care about panda stocks (graph two of Panel E). This lends support that for most people wildlife conservation exhibits the basic utility properties of 'normal goods'.

Finally, the last panel suggests that the likelihood of observing an individual that strictly prefers *in situ* conservation is enhanced at higher degrees of confidence in the conservation programme (i.e. at high scores in the 'programme' index). This highlights the importance of designing credible, reliable and believable wildlife conservation programmes especially in cases where valuation and appropriation of existence values is an integral part of the conservation strategy.

5.14. Discussion and Concluding Remarks

We can now address the issues raised in the introduction of the chapter. First, is there a WTP for the habitat required for the survival of the Panda? The Wolong Reserve consists of 200,000 hectares of land, capable of maintaining a population of approximately 500 giant pandas indefinitely, and this is approximately half of all the population that currently exists. Our study finds that there is a clear WTP for property rights for these panda lands. The nature of this demand is both convincing and logically coherent: the WTP for wildlife conservation is an increasing function of land (at a diminishing rate).

In order to put the WTP for panda lands into perspective, consider first that the current annual budget for Wolong reserve is about US$250,000, or $1.25 per hectare. And furthermore, under the current benefit sharing regime, the local peoples living in and near (and using) the reserve are receiving 4% of the annual budget, or approximately $0.05 per hectare. Given this low level of returns from panda conservation (i.e. the restrictions on the use of the reserve), it is readily apparent why it would be the case that local peoples would be hostile to both the reserve and to the pandas that live within it (see Swanson *et al.*, 1999).

The remainder of the budget is spent on enforcement measures (battling local peoples with objectives different from the reserve) and a captive breeding programme (keeping pandas in captivity rather than the reserve). The "cage scenario" used in the survey is based on the cages actually in use for panda *ex situ* conservation within Wolong Reserve. As panda populations in the reserve continue to decline, there is an ever-increasing share of Wolong pandas living in captivity rather than in their natural habitat. It has been argued that the case of the panda is exemplar of that occurring for many endangered species in many parts of the world.

Now consider the potential impact of the WTP for panda lands on the panda's plight. A very rough, though indicative, estimate of the aggregate WTP value for the Wolong reserve can be obtained by considering the total "population" from which our sample was derived. This was defined in Section 5.5 as the number of tourists visiting China from OECD countries. Using the median WTP and assuming five million OECD tourists visiting China (1997 WTO figures) provides a figure of US$50 million per annum for the Wolong reserve. This amounts to US$250/hectare. If the local people continued to receive a royalty of 4%, this would amount to a return of US$10 per hectare for them (under the existing benefit sharing regime). This would increase the returns from reserve status by a factor of twenty. If these payments were made contingent on the presence of pandas in the reserve, it would likewise greatly enhance the likelihood that the objectives of the local people and the panda conservationists would become congruent. This would then reduce the likelihood of intrusions into the reserve, and reduce the amount of the reserve budget that need be spent on monitoring and enforcement. In the sense that this WTP might be able to translate into a secure tenure by a stable population of pandas, it is apparent that this particular species clearly does have the capacity to purchase its property rights.

There is the clear capacity for using this charismatic species (panda) to acquire its own lands, but is it possible to make use of it as an instrument for nature conservation? The insistence on behalf of management agencies on saving particular species rests partly on the belief that this approach will be able to secure funding for the preservation of its habitat and by consequence of the (potential) biodiversity located wherein. It is widely believed to be the case that charismatic species are the flagships for general nature conservation.

Our study finds that this belief is well-founded. The total WTP for *in situ* panda conservation can be decomposed into three subcategories: genetic or stock values (27%), animal welfare values (30%) and implicit biodiversity values (43%). Existence values in total (animal welfare and biodiversity values) constitute 73% of the entire bid for *in situ* panda conservation. Thus, a substantial proportion of the value of the giant panda would be lost if *ex situ* conservation were to be pursued exclusively. Almost half of the value given to the species would not be expressed in the context of mere genetic preservation (as opposed to *in situ* conservation). Therefore it makes sense to use such charismatic species as nature conservation "flagships":

there is a lot of added value for conservation that would be wasted if the habitat were not tied to the charismatic species.[68]

But would the habitat be conserved irrespective of the charismatic species? In our study the WTP for *in situ* conservation drops to zero when the probability of survival of the flagship species is low. Hence, biodiversity values in this case are dependent on the preservation of the flagship species. The giant panda is not only a potential instrument for conservation, it is potentially a necessary instrument.

In conclusion three final points are made. First, the results from this study suggest that the *ex situ* policies that are currently being purposed for the conservation of the numerous species cannot be justified by an appeal to so called existence values. The current study attempted to show that existence values have little to do with the preservation of the stock of a species but instead stem from its 'naturalness'. Hence, claims for appropriating existence value made by several conservation agencies in order to fund *ex situ* policies would not be welfare improving and may lead to overall loss of public support for nature conservation.[69]

Secondly, Van Kooten and Bulte (2000) have acknowledged that the expansion of *ex situ* wildlife polices will pose new forms of trade-offs to policy makers. For example, in addition to tradeoffs concerning which species to conserve and at what optimal stock levels, policy makers will increasingly have to face the added tradeoffs over which species are to be saved *in situ* and which *ex situ* as well as what level of species wildness or naturalness, would society

[68] These results are corroborated by the sentiments and attitudes expressed by various conservation organisations. For example, in response to the latest $10 million transfer of two new Giant Pandas to the Washington Zoo for the purpose of captive breeding Dr. Will Travers, CEO Born Free Foundation, asks "Why have Giant Pandas in zoos at all?" and acknowledges that the "the $10 million Panda Exchange Deal, ... will do little or nothing to address the habitat issue. It will, instead, try to overcome the seemingly chronic inability of the Western zoo industry to breed this crowd pulling species in captivity." And concludes that "Should the interventionist policies of the National Zoo and others eventually succeed in getting (I hesitate to use the word 'forcing') Giant Pandas to breed, then I suspect the outcome will be the perpetuation of this species as part of a living museum – the zoo – instead of as part of a dynamic, evolutionary, natural eco-system. Giant Pandas belong in the wild and we should pay to keep it that way." (Washington post, December 4th, 2000).

[69] Numerous marketing studies, that have been conducted on behalf of zoos that host captive breeding programmes, have found that public support for these organisations drops dramatically (by more than 50%) if people are told that these programmes do not contribute to *in situ* conservation. Modern captive breeding centres market themselves as modern Arks offering a temporary solution to threatened species. Yet, Section 5.2 showed that *ex situ* polices do not contribute to habitat conservation and have even become substitute (as opposed to complementary) policies to *in situ* conservation.

be willing to support. In essence, the detachment of the *ex situ* and *in situ* policies implies that management of the societal portfolio of natural and man-made assets not only entails decisions over the stock of species but also over its composition of *ex situ* and *in situ* species. [70] Biologists have acknowledged that these trade-offs are eminent and are engaging on discussions on which animals should and which should not 'enter the ark' (for example see the discussion in Balmford, 2000). To the degree that input from individual preferences contributes to making these trade-offs, more valuation studies are required that would aim at addressing the issues raised in this chapter. To this end, the use of choice-modelling techniques may play an important role.

Lastly, even if the *in situ approach* to conserve flagship species is pursued it is questionable if this conservation path will lead to biodiversity conservation. The debate over the most appropriate means for conserving biodiversity is often polarised between advocates of the so-called "species" and "ecosystems" approach to conservation. The former focuses on the protection, of endangered, often high profile, species. The latter seeks to conserve entire ecosystems (irrespective of whether they host any high profile species) with the sole aim of preserving as much diversity as possible (Van Kooten and Bulte 2000). Irrespective of which approach is preferable at a normative level, brief consideration of the results of this study and the prevailing policies indicates that the construct of the charismatic species is now a "fact of life".[71] Therefore, the fate of nature conservation is now inextricably interlinked with the fate of particular charismatic species. The construct of the important endangered species has been created and sold, and policy makers now are going to have to live with the phenomenon. Hence the final issue that needs to be addressed concerns the extent the flagship approach is capable of contributing to wider biodiversity conservation. Van Kooten and Bulte (2000) identify two conditions for this to be the case: habitats that are species rich in one taxon must also be species rich for others and/or rare and endangered species should occur in species-rich areas. Yet, more often than not neither of these conditions are met. Work by Prendergast *et al.* (1993), and Williams *et al.* (2000a) and (2000b), and Leader-Williams and Dublin (2000)

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[70] See Van Kooten and Bulte (2000) and Weitzman (1998).

[71] For example, Metrick and Wietzman (1996) show that 54% of all wildlife funding in the US is devoted to the conservation of just 1.8% of all listed endangered animals. Moreover, they show that the amount of funding spent on the conservation of a particular species does not depend on ecological criteria (such rarity and degree of endangerment) but rather on the public appeal and "charisma" of the species.

show that the flagship approach has little positive effect on biodiversity conservation (for widely accepted ecological definition of biodiversity). This is so because biodiversity hot-spots do not usually host flagship species. Therefore, the costs of the instrument lie in the constraints that exist on the ranges of charismatic species. Given that the flagship approach is not delivering higher levels of biodiversity conservation then policy makers may be faced with trade-offs between conserving diversity *per se* and certain rare (and perhaps high profile) species (van Koote and Bulte 2000). Alternatively, the policy maker might attempt to educate the population to discard the "charismatic species" approach (at the risk of destroying some WTP for nature conservation), or alternatively attempt to create some new charismatic species that are more closely associated with the various biodiversity hotspots. Perhaps it is time to replace the panda (as the symbol of international nature conservation) with a beetle?

5.15. Appendix 1 – Tables and Figures

Table 5.1 Number of Species recommended for re-introduction from 24 IUCN Species Action Plans.

Image removed due to third party copyright

Source: Olney et al (1994).

Table 5.2 Current Captive Breeding Programmes

Image removed due to third party copyright

Source: Magin et al. (1994).

Figure 5.1 Historical Dispersion of Panda Population, present Panda habitat and distribution of largest Panda Reserves.

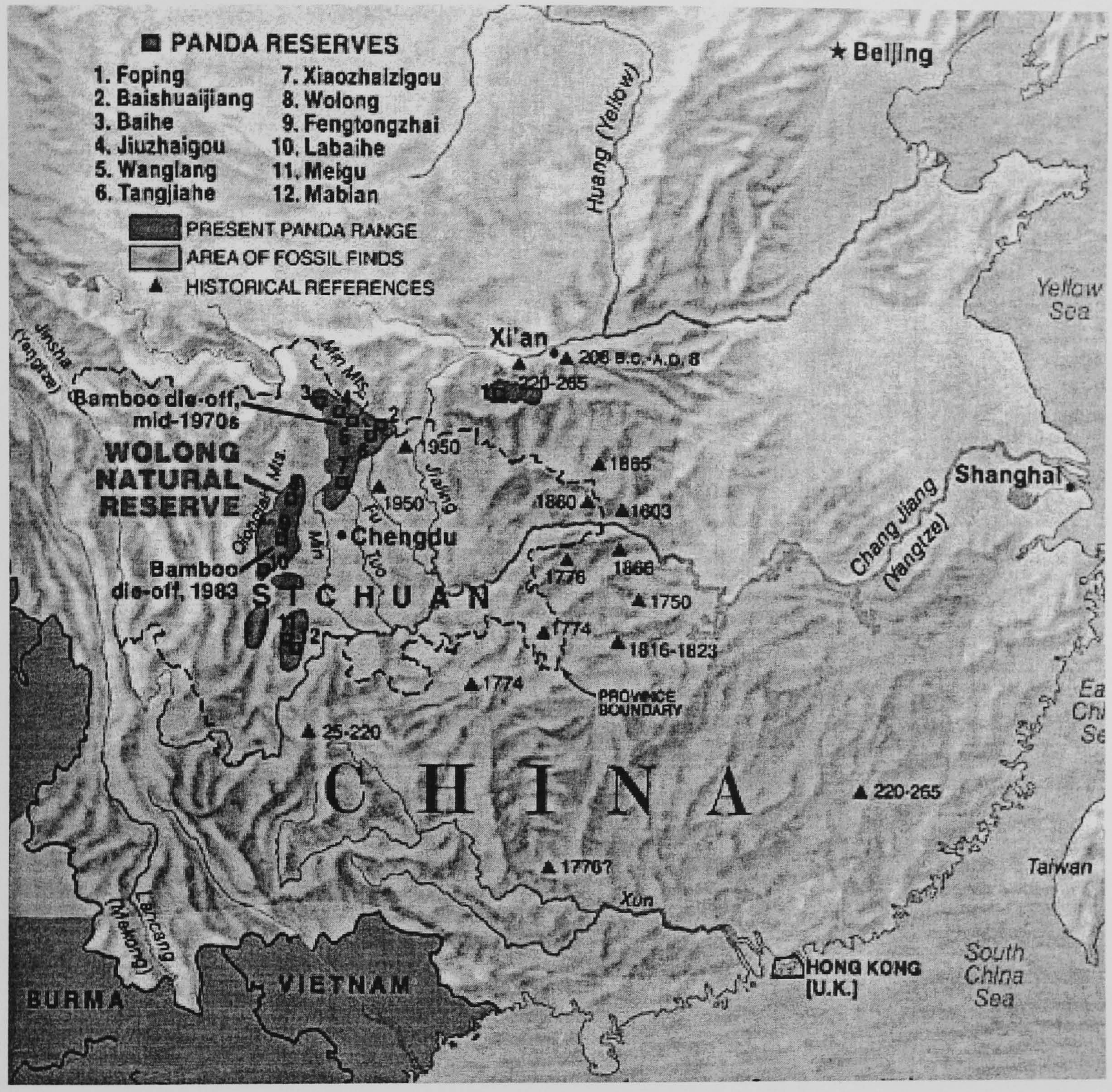


Figure 5.2 Change in the amount of Panda habitat in Wolong before and after the establishment of the reserve in march 1975 (*Source: Liu et al 2001*).

Image removed due to third party copyright

Figure 5.3 First Conservation Scenario: Pandas in Cages (100 sq. m. per panda)

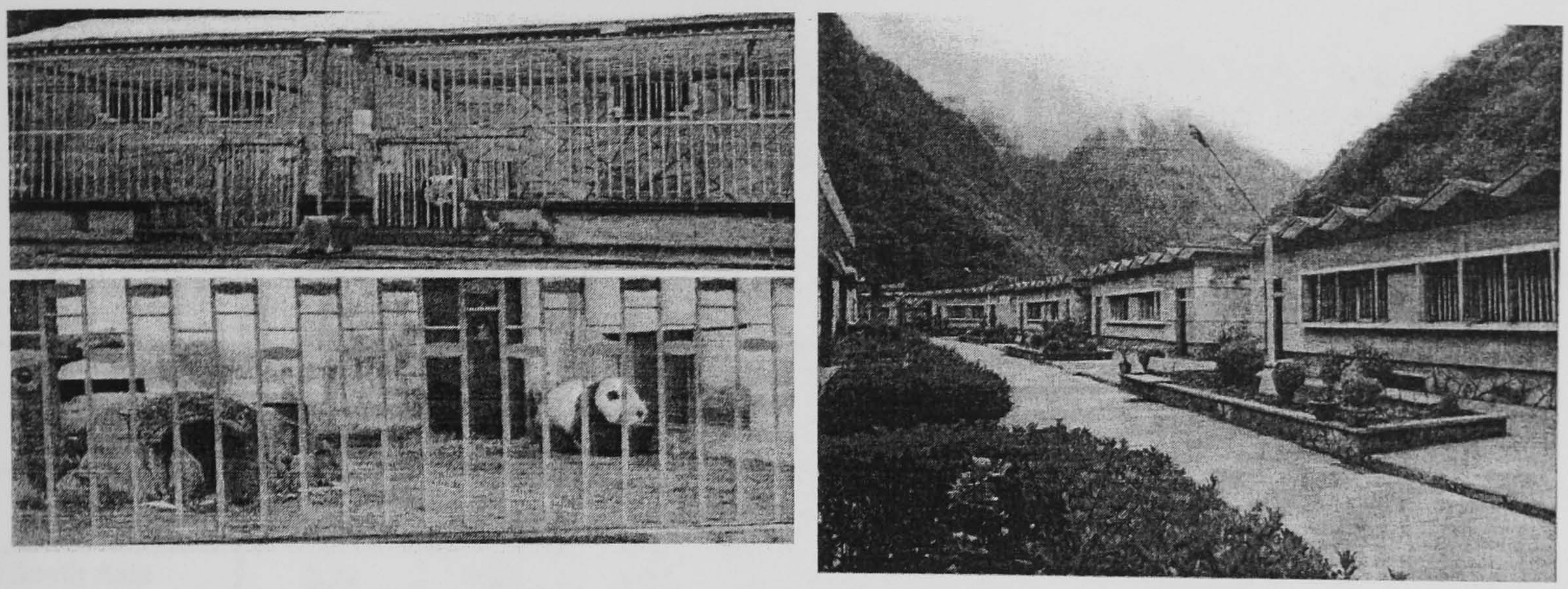


Figure 5.4 Second Conservation Scenario: Pandas in Pens (0.5 ha. per panda).

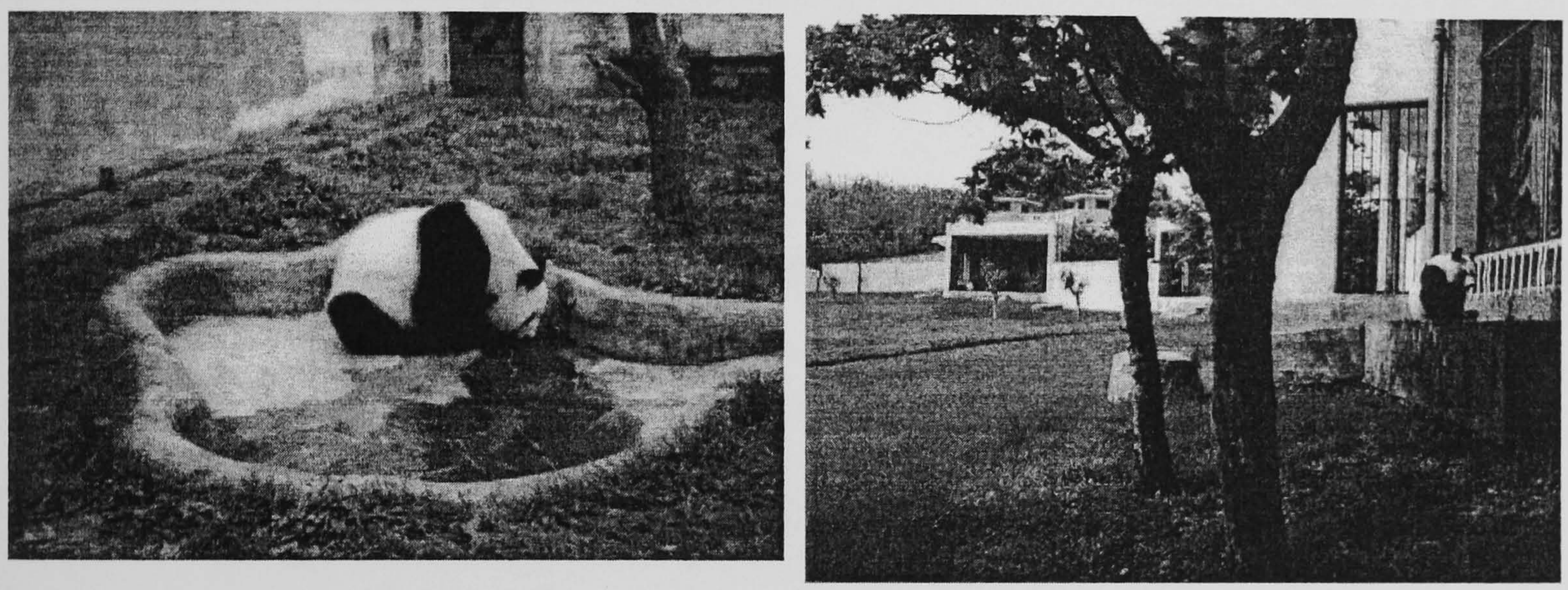


Figure 5.5: Third Conservation Scenario: Pandas in their Natural Habitat (400 ha. per panda).

Note: these figures are a subset of the visual aids used in the final survey.

Table 5.3 Sample Representativeness.

	Market share of tourist by country of origin		SURVEY GROUP N=305 (%)	1997 CITS Data	Sample	1997 CITS Data	Sample	1997 CITS Data	Sample
	1993 (%)	1995 (%)	Sample (%)	Income (US$)		Age (years)		% of People with University Degree	
Europe	34.19	30.61	33.88	3600	4328	45	47	0.60	0.64
North America	11.12	11.01	48.67	3850	4721	58	57	0.65	0.75
South/Latin America	1.27	1.54	0.97	3100	3750	48	40	0.78	0
East Asia/Pacific	50.62	56.12	14.51	3650	4179	43	37	0.7	0.8
South Asia	2.21	0.29	1.97	2600	3500	41	37	0.45	0.33
Africa	0.59	0.43	0	-	-	-	-	-	-
	100	100	100	3700	4500	54	49	79	71.4

Source: World Tourism Organization, Yearbook of Tourism Statistics, 1995.; CITS
Note: Figures include only tourists and excluded visitors for the purpose of business, research or any other non-recreational activity

Table 5.4 Socio-economic Characteristics of Sample.

Socio-economic profile		Percent
Gender:		
Male		50.8
Female		50.2
Marital Status:		
Single		25.3
Married		59.9
Divorced		7.2
Widowed		7.6
Age group:		
>20		3.0
20-30		9.2
31-40		13.1
41-50		21.6
51-60		23.6
61-70		19.0
over 70		10.5
Mean Age: 49 years old		
Education:		
Primary School		1.6
High School		14.5
Vocational training		9.9
University/College Degree		48.7
Postgraduate Degree		22.7
Occupation:		
Not working		6.4
Looking after house full time		5.7
Employed part-time		7.0
Retired		31.1
Employed full-time		49.8
Average Household Size:	3 people	
Mean Monthly Disposable Income:	S$4500	

Table 5.5 Sample Attitudes Towards the Survey

Opinion about Survey	(%)
Interesting	55.8
Boring	0.7
Too Long	32.7
Difficult to understand	6.5
Partial	4.4

Table 5.6 Sample Summary Statistics of WTP responses

	WTP_{cage}	WTP_{pen}	$WTP_{reserve}$
Mean	3.90	8.43	14.86
Median	1.00	5.00	10.00
Standard Deviation	5.34	10.13	15.69
Minimum	0.00	0.00	0.00
Maximum	30.00	75.00	100.00
% of zero responses	37.05	24.59	7.54
Sample Size	305	305	305

Figure 5.6 WTP values for three Panda Conservation scenarios (mean and median figures in 1988 US$)

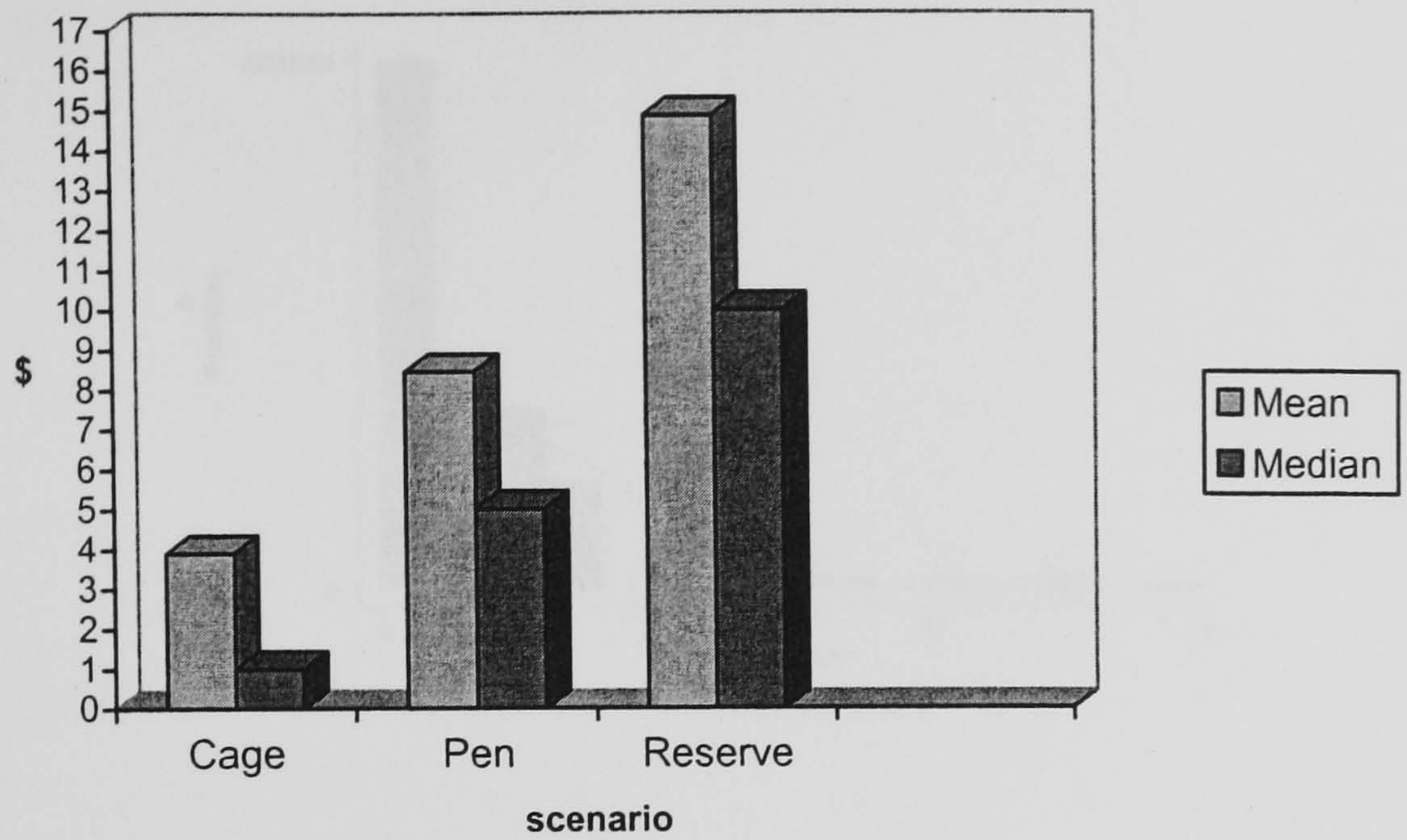


Figure 5.7 Distribution of WTP Responses.

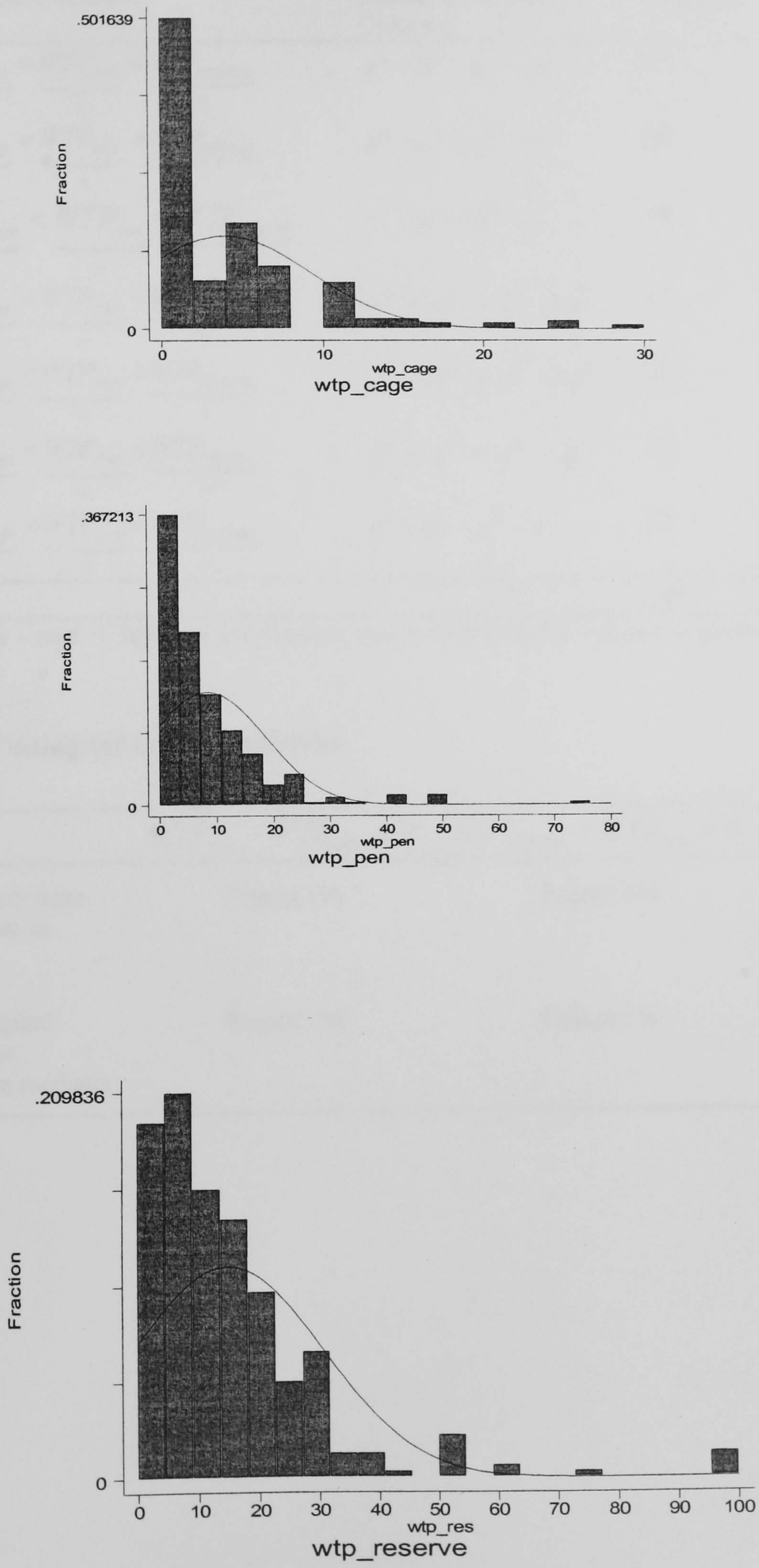


Table 5.7 Bid Sequences and Implied Preference Ordering of Programmes

No.	Stated Bid Sequence	Implied Preference Ordering	Frequency	% N=305
1	$\underbrace{WTP_{cage}}_{0} = \underbrace{WTP_{pen}}_{0} = \underbrace{WTP_{reserve}}_{0}$	$q^0 \sim q^1 \sim q^2 \sim q^3$	23	7.54
2	$\underbrace{WTP_{cage}}_{+} = \underbrace{WTP_{pen}}_{+} = \underbrace{WTP_{reserve}}_{+}$	$q^0 \prec q^1 \sim q^2 \sim q^3$	45	14.75
3	$\underbrace{WTP_{cage}}_{+} < \underbrace{WTP_{pen}}_{+} = \underbrace{WTP_{reserve}}_{+}$	$q^0 \prec q^1 \prec q^2 \sim q^3$	38	12.46
4	$\underbrace{WTP_{cage}}_{+} = \underbrace{WTP_{pen}}_{+} < \underbrace{WTP_{reserve}}_{+}$	$q^0 \prec q^1 \sim q^2 \prec q^3$	13	4.26
5	$\underbrace{WTP_{cage}}_{+} < \underbrace{WTP_{pen}}_{+} < \underbrace{WTP_{reserve}}_{+}$	$q^0 \prec q^1 \prec q^2 \prec q^3$	96	31.48
6	$\underbrace{WTP_{cage}}_{0} < \underbrace{WTP_{pen}}_{+} < \underbrace{WTP_{reserve}}_{+}$	$q^0 \sim q^1 \prec q^2 \prec q^3$	38	12.46
7	$\underbrace{WTP_{cage}}_{0} = \underbrace{WTP_{pen}}_{0} < \underbrace{WTP_{reserve}}_{+}$	$q^0 \sim q^1 \sim q^2 \prec q^3$	52	17.05
			305	100

Notes: Where $\sim$ and $\prec$ refers to indifference and strict preference relation respectively.

Table 5.8 Testing for Scope Sensitivity

	$WTP_{pen} - WTP_{cage} = 0$	$WTP_{reserve} - WTP_{pen} = 0$	$WTP_{reserve} - WTP_{cage} = 0$
Mann-Whitney tests for differences in means	Reject 1%	Reject 1%	Reject 1%
Wilcoxon Signed Ranks test for differences in medians	Reject 1%	Reject 1%	Reject 1%

Table 5.9 Random Effects Tobit

	WTP Pandas			
	Coef.	Std. Err.	t-value	P-value
Variable				
Land (in logs)	1.314	0.071	18.538	0.000
Animal welfare index	3.690	0.728	5.070	0.000
Programme Index	2.129	0.811	2.626	0.009
Income (logs)	7.845	1.095	7.162	0.000
Constant	-68.554	7.917	-8.659	0.000
LnL	-2808.4134			
Wald chi2(4)	497.91			
Prob > chi2	0.0000			
N	915			

Table 5.10 Estimated Total and Marginal WTP to purchase land for panda conservation

Land protected* (Hectares)	Estimated WTP per individual (US$)	Estimated Marginal WTP per individual per hectare (US$)	Aggregate values per hectare** (US$)
1	0.496968	-	-
5	2.85134	0.09417	470874
50	3.522564	0.03356	167806
200	5.344155	0.01214	60720
250	5.637366	0.00586	29321
1000	7.458957	0.00243	12144
5000	9.573758	0.00053	2644
20000	11.39535	0.00012	607
50000	12.59935	0.0000401	201
100000	13.51015	0.0000182	91
150000	14.04293	0.0000107	53
200000	14.42095	0.0000076	38
250000	14.71416	0.0000059	29
300000	14.95373	0.0000048	24
350000	15.15628	0.0000041	20

**5 hectares corresponds to the entire cage scenario, 250 to the pen and 2000 to the reserve sceanrio.*
***Assuming 5 million tourists*

Figure 5.8 Predicted Diminishing Marginal WTP/Hectare from random effects Tobit.

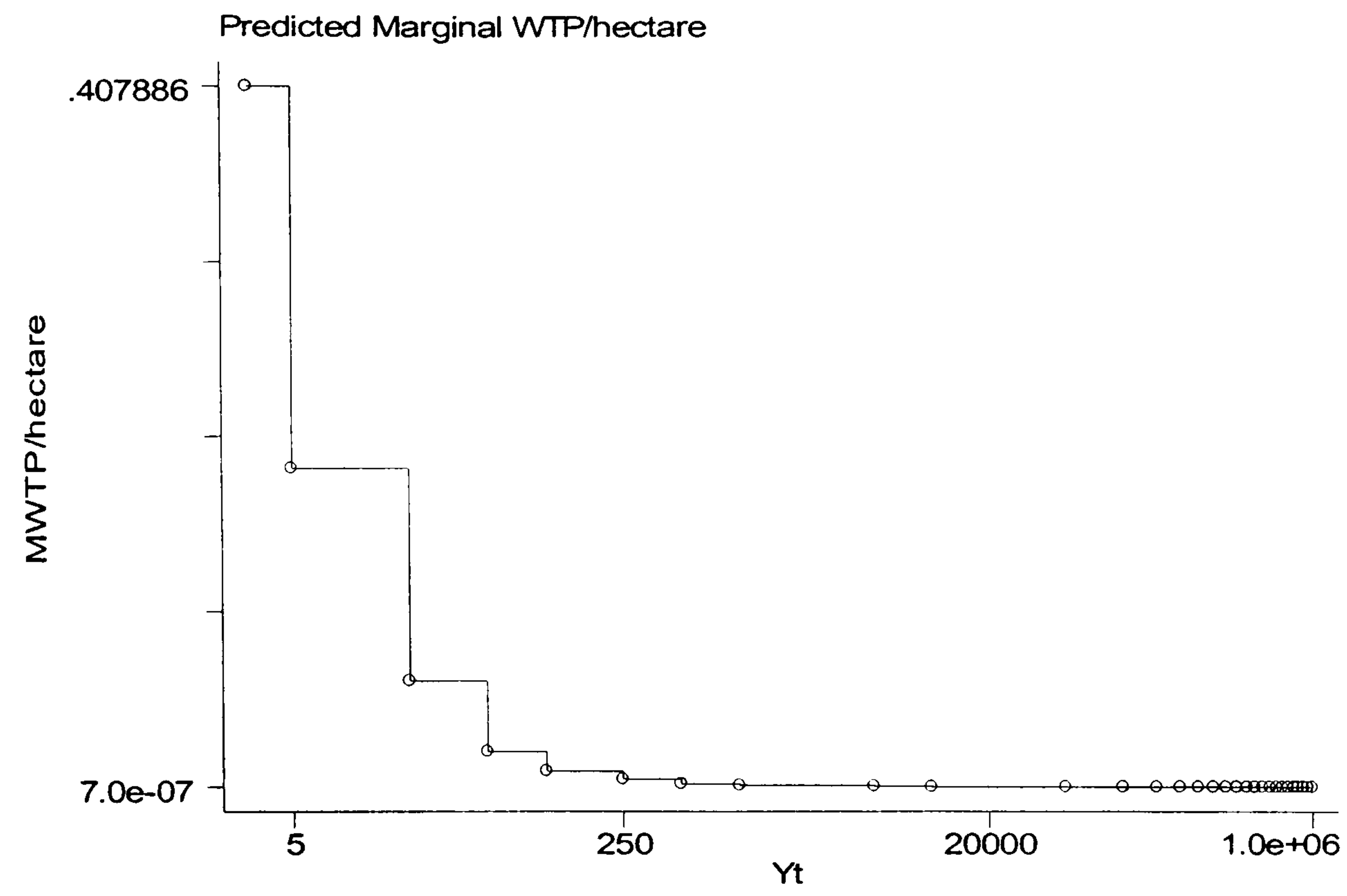


Table 5.11 Decomposition of WTP for the Giant Panda

	WTP for Total value (US$)	WTP for gene flow (US$)	WTP for animal welfare value (US$)	WTP for habitat/wildness value values (US$)
WTP_{cage}	3.90 (100%)	3.90 (100%)	0 (0%)	0 (0%)
WTP_{pen}	8.43 (100%)	3.90 (46%)	4.53 (54%)	0 (0%)
$WTP_{reserve}$	14.86 (100%)	3.90 (27%)	4.53 (30%)	6.43 (43%)

Note: percentage of total value in parentheses.

Figure 5.9 Component values for in situ panda conservation

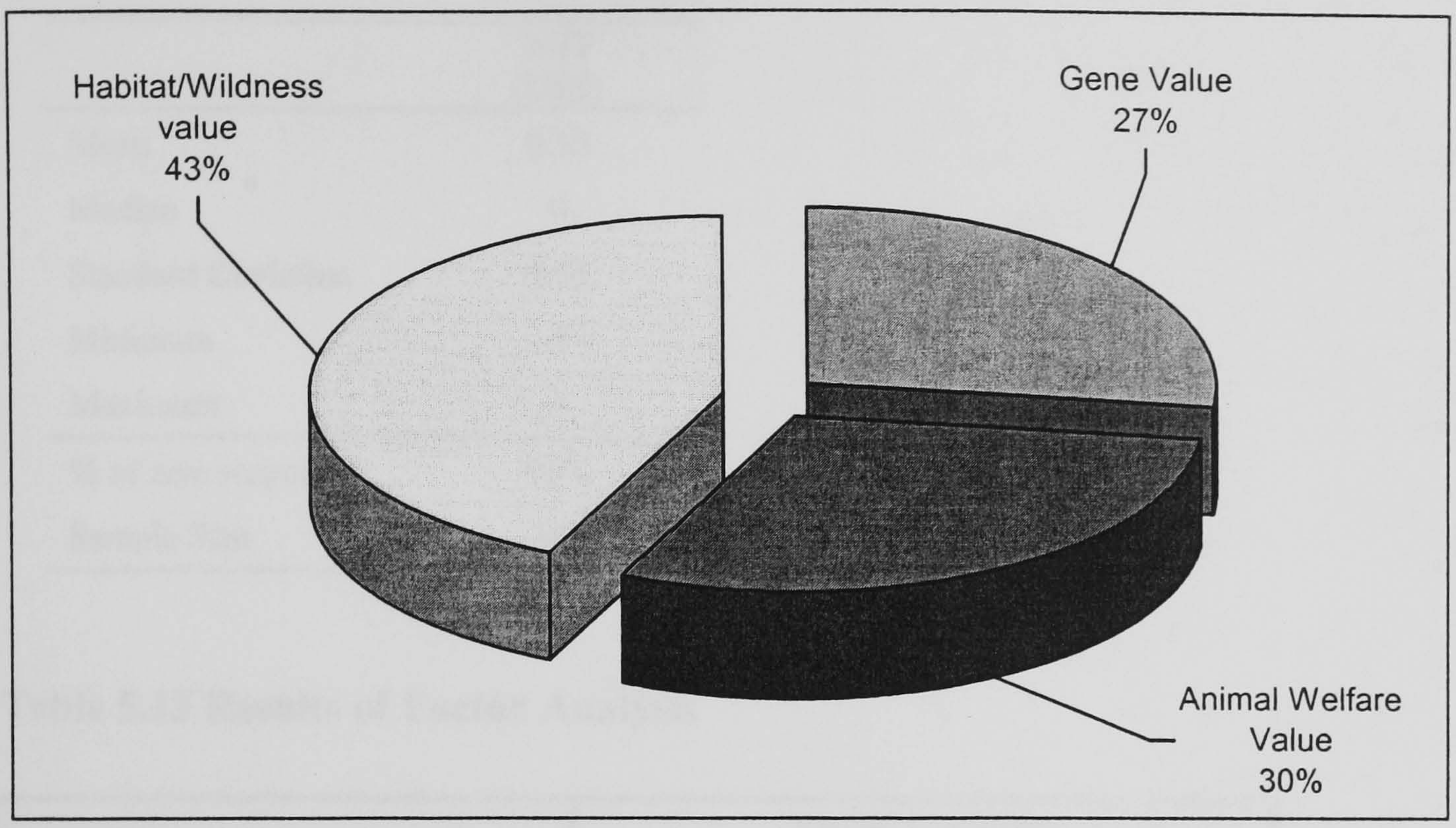


Table 5.12 Summary Statistics of WTP values for Panda conservation when probability of panda survival is low.

	WTP (US$)
Mean	0.10
Median	0
Standard Deviation	0.43
Minimum	0
Maximum	3
% of zero responses	95%
Sample Size	305

Table 5.13 Results of Factor Analysis

	Factor Loadings		
	Factor 1 *(Animal welfare)*	Factor 2 *(Ethics)*	Factor 3 *(Sympathy)*
Green Foods	0.28	0.10	0.54
Vegetarianism	0.07	0.60	0.02
Pet Ownership	0.12	0.09	0.53
Willingness to wear fur	0.37	0.06	0.09
Willingness to use cosmetic tested on animals	0.64	0.14	0.22
Willingness to use medicine tested on animals	0.15	0.61	0.13
Willingness to support ban on leg hold traps	0.71	0.07	0.08
Willingness to support for animal welfare society	0.69	0.08	0.10
Eigenvalues	2.1	1.32	1.01

Table 5.14 Description of independent Variables

Name of Variable	Description
Income (logs)	Personal disposable annual income in 1998 US Dollars
Sex	1=male; 0=female
Age	In years; Range 18-70
Programme Index	Index of subjective assessment of the credibility of the panda conservation programme. Respondents provided answers on five-point Likert scale to the questions: 1. What kind of support do you think the Wolong Panda Conservation Programme would receive from foreigners visiting China? 2. Do you think that the airport tax increase described above is a fair method of financing the expenses connected with the implementation of the Wolong Panda Conservation Programme? 3. To what degree do you trust the capabilities of the relevant authorities to implement and enforce conservation measures for Giant Pandas if they have adequate funding? 4. If the Wolong Panda Conservation Programme would be implemented, do you think it would attain the desired conservation objective (e.g. sustaining a population of 500 Pandas)? Calculation of index: $\left(\sum_{1}^{4} m_i\right)/5$ Range 1-5
Use/Non-use index	Index of *relative* importance of instrumental or use over non-instrumental or non-use reasons for wanting to preserve the Giant Panda. Calculation of index: $\frac{\sum \text{score of responses}}{\#\text{ of responses}}$ Range: 0-5
Animal welfare index	Factor score from factor analysis.
Ethics index	Factor score from factor analysis.
Sympathy Index	Factor score from factor analysis.

Table 5.15 Comparison of explanatory variables of WTP for gene, pure animal welfare and implicit biodiversity values.

	WTP_{cage}				$WTP_{pen-cage}$				$WTP_{reserve-pen}$			
	Coef.	Std. Err.	t-value	P-value	Coef.	Std. Err.	t-value	P-value	Coef.	Std. Err.	t-value	P-value
Participation Decision												
Use/Non-use index	4.87	1.34	3.63	0.00	-	-	-	-	-	-	-	-
Animal welfare index	1.63	0.67	2.45	0.01	-	-	-	-	-	-	-	-
Ethics index	-1.56	0.57	-2.74	0.01	-	-	-	-	-	-	-	-
Sympathy Index	-1.19	0.61	-1.95	0.05	-	-	-	-	-	-	-	-
Programme Index	0.18	0.60	0.29	0.77	-	-	-	-	-	-	-	-
Income (logs)	-0.39	0.53	-0.74	0.46	-	-	-	-	-	-	-	-
Sex	0.54	0.68	0.80	0.42	-	-	-	-	-	-	-	-
Age	-0.03	0.02	-1.44	0.15	-	-	-	-	-	-	-	-
Constant	-0.82	4.90	-0.17	0.87	-	-	-	-	-	-	-	-
Payment (WTP) Decision												
Use/Non-use index	0.75	0.23	3.34	0.00	-0.86	0.23	-3.74	0.00	-2.14	0.29	-7.49	0.00
Animal welfare index	1.29	0.31	4.12	0.00	1.76	0.38	4.68	0.00	1.29	0.36	3.62	0.00
Ethics index	-0.42	0.32	-1.29	0.20	0.77	0.37	2.08	0.04	0.40	0.31	1.30	0.19
Sympathy Index	-1.04	0.37	-2.84	0.01	1.26	0.41	3.08	0.00	0.38	0.35	1.08	0.28
Programme Index	1.05	0.35	2.99	0.00	1.09	0.39	2.80	0.01	1.32	0.39	3.41	0.00
Income (logs)	2.20	0.50	4.44	0.00	1.46	0.58	2.49	0.01	2.74	0.53	5.12	0.00
Sex	0.44	0.48	0.91	0.36	-0.58	0.49	-1.17	0.24	-0.31	0.45	-0.69	0.49
Age	0.01	0.01	0.38	0.71	-0.05	0.02	-2.87	0.00	0.00	0.01	0.33	0.74
Constant	-19.03	4.01	-4.74	0.00	-6.58	4.15	-1.58	0.11	-18.68	4.13	-4.52	0.00
σ												
Sex	-0.29	0.11	-2.55	0.01	-	-	-	-	-0.22	0.11	-2.06	0.04
Age	-0.01	0.00	-1.90	0.06	-	-	-	-	-	-	-	-
Income (logs)	-	-	-	-	0.65	0.14	4.57	0.00	-	-	-	-
Constant	1.64	0.23	7.20	0.00	-3.69	1.05	-3.50	0.00	1.24	0.13	9.62	0.00
ρ	0.58	0.21	2.76	0.01	-	-	-	-	-	-	-	-
θ	0.18	0.04	4.85	0.00	0.12	0.03	3.94	0.00	0.19	0.03	5.76	0.00
lnL	-598.39992				-555.90938				-669.98419			
Wald chi2(8)	20.54				81.37				82.61			
Prob > chi2	0.0085				0.000001				0.000001			
Sample	305				203*				282*			
Model	IHS Dependent				IHS Tobit				IHS Tobit			

Notes"* not all individuals provided data on differences.

Table 5.16 Multinomial logit model preference orderings for panda conservation scenarios.

	Variable	Coef.	Std. Err.	z	P-value
$y=2$	Use/Non-use index	1.178	0.405	2.909	0.004
	Animal welfare index	0.189	0.585	0.323	0.747
	Ethics index	1.147	0.821	1.398	0.162
	Sympathy Index	-6.214	1.555	-3.997	0.000
	Programme Index	0.732	0.550	1.330	0.184
	Income (logs)	1.099	0.907	1.212	0.225
	Constant	-15.942	6.990	-2.281	0.023
$y=3$	Use/Non-use index	0.625	0.343	1.821	0.069
	Animal welfare index	2.164	0.561	3.861	0.000
	Ethics index	-0.022	0.606	-0.036	0.971
	Sympathy Index	0.526	0.692	0.760	0.447
	Programme Index	1.509	0.540	2.793	0.005
	Income (logs)	1.579	0.874	1.807	0.071
	Constant	-16.139	6.632	-2.434	0.015
$y=4$	Use/Non-use index	-0.885	0.367	-2.412	0.016
	Animal welfare index	2.961	0.582	5.086	0.000
	Ethics index	0.247	0.596	0.414	0.679
	Sympathy Index	0.161	0.688	0.235	0.815
	Programme Index	1.360	0.573	2.375	0.018
	Income (logs)	1.809	0.916	1.975	0.048
	Constant	-13.122	6.814	-1.926	0.054
$y=5$	Use/Non-use index	-3.253	0.495	-6.570	0.000
	Animal welfare index	2.054	0.626	3.281	0.001
	Ethics index	1.433	0.648	2.212	0.027
	Sympathy Index	0.084	0.732	0.114	0.909
	Programme Index	2.240	0.652	3.433	0.001
	Income (logs)	1.892	0.974	1.941	0.052
	Constant	-14.234	7.198	-1.978	0.048
	N	305			
	LR chi2(24)	524.87			
	Prob > chi2	0.00001			
	Pseudo R^2	0.5875			
	Log likelihood	-184.27491			

Baseline category: $y=1$ *where y denotes a particular type of preference ordering and the dependent variable is* $\Pr(y=m)$ *such that:*

$y=1$ $\quad \underbrace{WTP_{cage}}_{0} = \underbrace{WTP_{pen}}_{0} = \underbrace{WTP_{reserve}}_{0}$

$y=2$ $\quad \underbrace{WTP_{cage}}_{+} = \underbrace{WTP_{pen}}_{+} = \underbrace{WTP_{reserve}}_{+}$

$y=3$ $\quad \underbrace{WTP_{cage}}_{+} < \underbrace{WTP_{pen}}_{+} = \underbrace{WTP_{reserve}}_{+}$

$y=4$ $\quad \underbrace{WTP_{cage}}_{+} \leq \underbrace{WTP_{pen}}_{+} < \underbrace{WTP_{reserve}}_{+}$

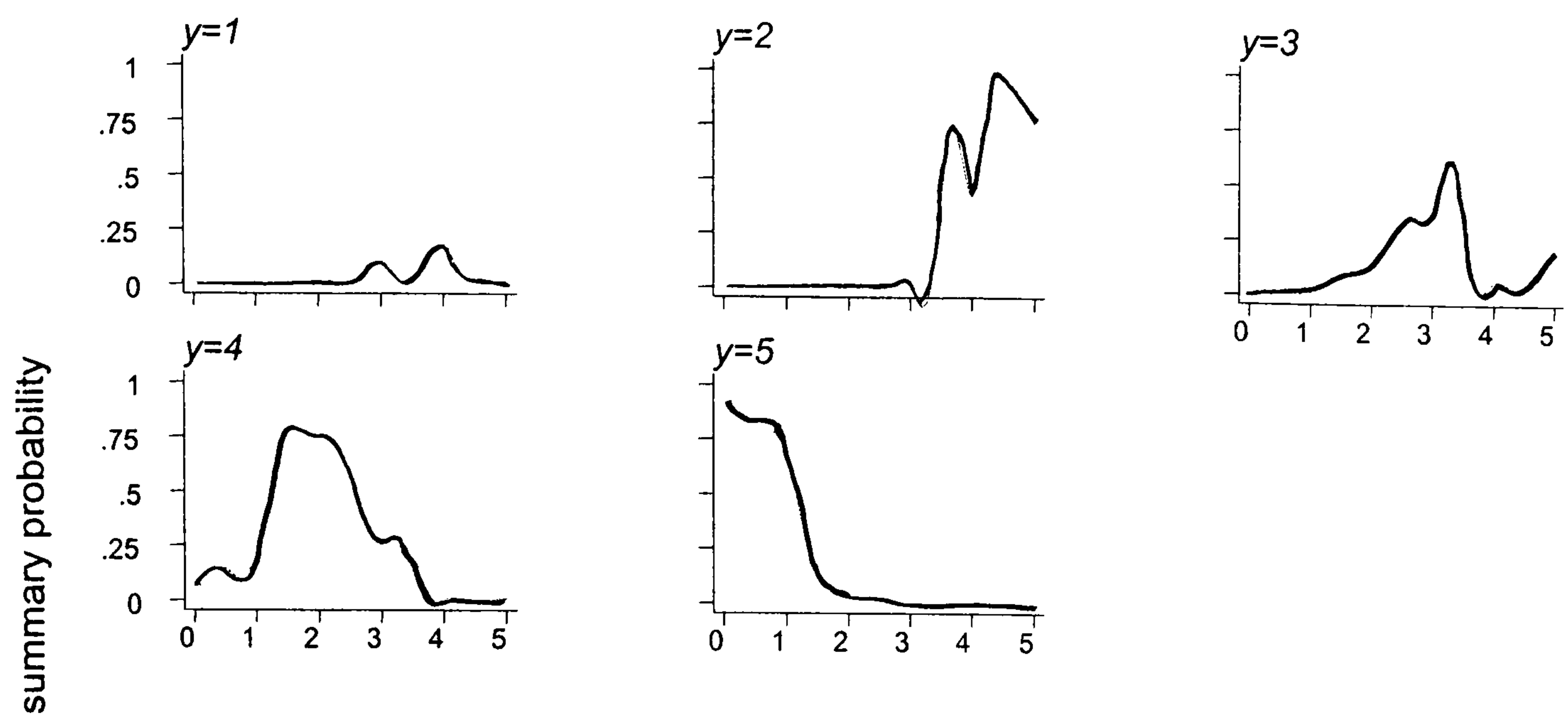
$y=5$ $\quad \underbrace{WTP_{cage}}_{0} = \underbrace{WTP_{pen}}_{0 or +} < \underbrace{WTP_{reserve}}_{+}$

Table 5.17 Marginal Effects for multinomial model**

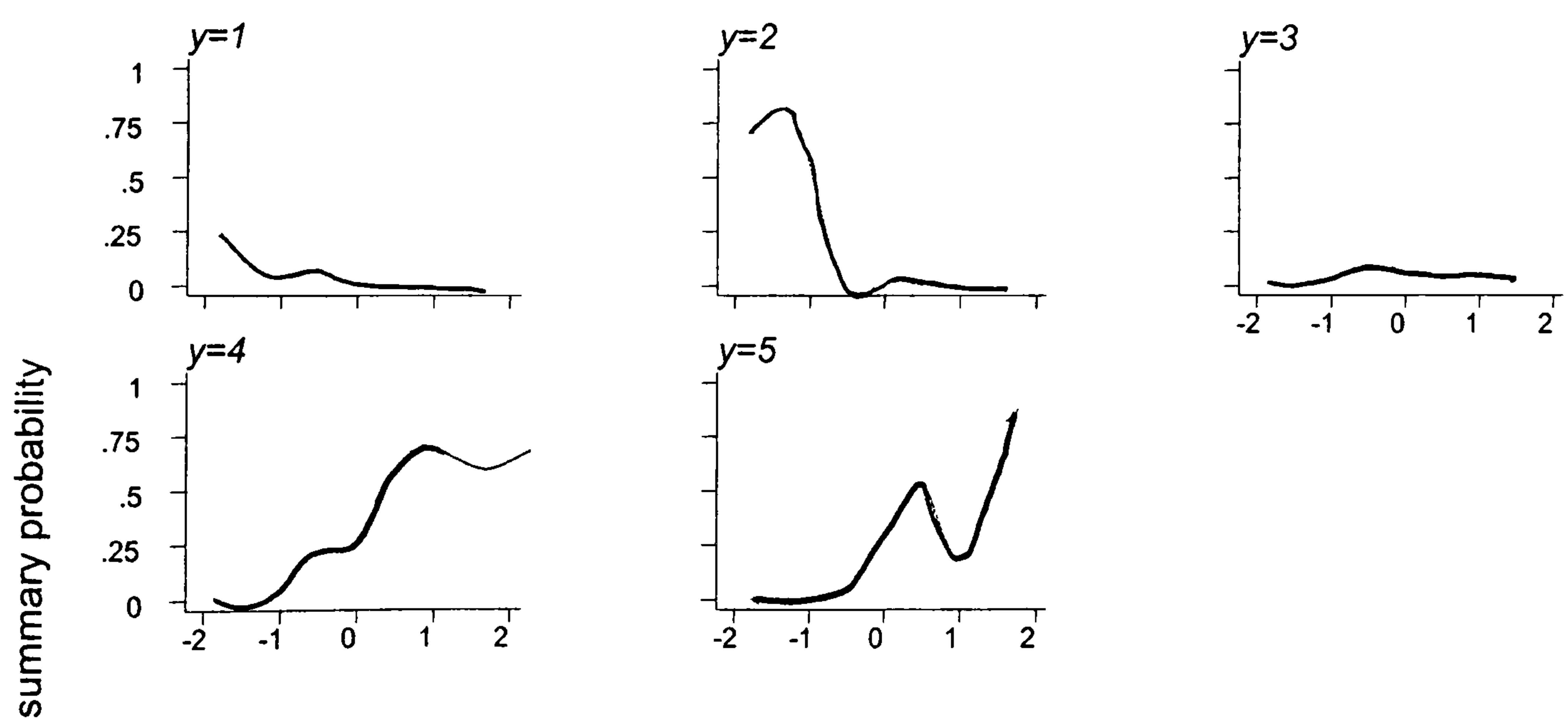
	$\frac{\partial \Pr(y=m/\mathbf{x})}{\partial x_i}$	Std. Err.*	z	p-value	95% C.I.		$\bar{x}_i$
$y=1$							
Use/Non-use index	0.018	0.013	1.430	0.153	-0.007	0.043	1.93387
Animal welfare index	-0.062	0.034	-1.830	0.067	-0.128	0.004	-7.8E-11
Ethics index	-0.007	0.013	-0.530	0.599	-0.032	0.018	2.9E-11
Sympathy Index	-0.005	0.016	-0.310	0.757	-0.036	0.026	1.1E-11
Programme Index	-0.033	0.020	-1.640	0.102	-0.073	0.007	3.25328
Income (logs)	-0.040	0.026	-1.560	0.120	-0.091	0.010	7.64945
$y=2$							
Use/Non-use index	0.003	0.003	0.790	0.427	-0.004	0.009	1.93387
Animal welfare index	-0.003	0.004	-0.780	0.437	-0.011	0.005	-7.8E-11
Ethics index	0.001	0.002	0.740	0.458	-0.002	0.004	2.9E-11
Sympathy Index	-0.008	0.010	-0.870	0.386	-0.027	0.011	1.1E-11
Programme Index	-0.001	0.001	-0.640	0.521	-0.004	0.002	3.25328
Income (logs)	-0.001	0.001	-0.560	0.576	-0.004	0.002	7.64945
$y=3$							
Use/Non-use index	0.255	0.052	4.930	0.000	0.153	0.356	1.93387
Animal welfare index	-0.092	0.067	-1.380	0.167	-0.223	0.038	-7.8E-11
Ethics index	-0.056	0.053	-1.070	0.284	-0.159	0.047	2.9E-11
Sympathy Index	0.058	0.061	0.950	0.342	-0.061	0.176	1.1E-11
Programme Index	0.015	0.059	0.260	0.795	-0.100	0.131	3.25328
Income (logs)	-0.028	0.087	-0.320	0.752	-0.199	0.144	7.64945
$y=4$							
Use/Non-use index	-0.078	0.068	-1.150	0.249	-0.211	0.055	1.93387
Animal welfare index	0.207	0.075	2.770	0.006	0.061	0.353	-7.8E-11
Ethics index	-0.029	0.059	-0.500	0.619	-0.145	0.086	2.9E-11
Sympathy Index	-0.034	0.064	-0.530	0.593	-0.160	0.091	1.1E-11
Programme Index	-0.046	0.066	-0.700	0.483	-0.176	0.083	3.25328
Income (logs)	0.056	0.091	0.610	0.540	-0.122	0.234	7.64945
$y=5$							
Use/Non-use index	-0.197	0.048	-4.090	0.000	-0.292	-0.103	1.93387
Animal welfare index	-0.049	0.033	-1.500	0.134	-0.113	0.015	-7.8E-11
Ethics index	0.091	0.034	2.660	0.008	0.024	0.158	2.9E-11
Sympathy Index	-0.010	0.025	-0.400	0.693	-0.060	0.040	1.1E-11
Programme Index	0.065	0.032	2.030	0.043	0.002	0.128	3.25328
Income (logs)	0.013	0.032	0.410	0.685	-0.049	0.075	7.64945

*Notes: * estimated via delta method **Marginal effects calculated at sample means*

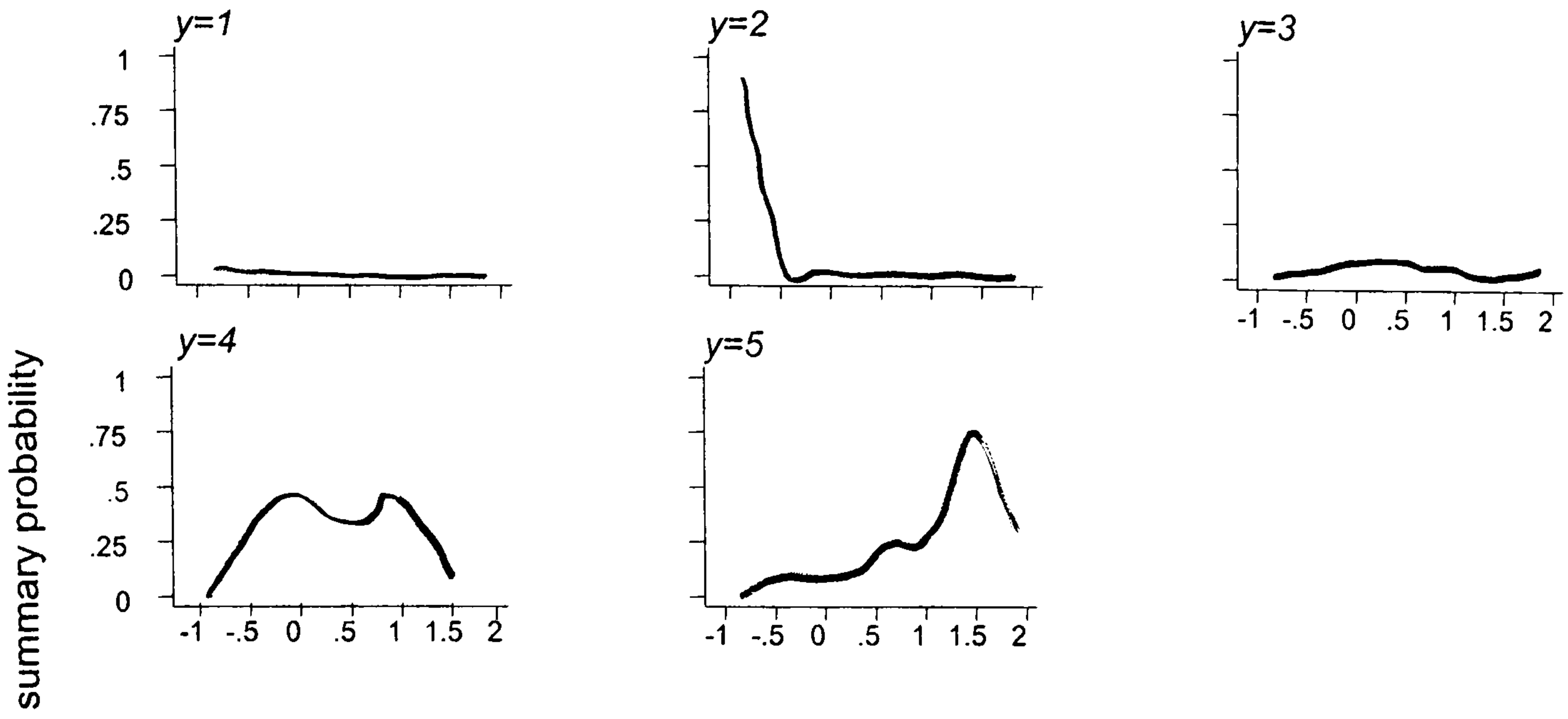
Figure 5.10 Summary Probabilities and taste and demographic variables.



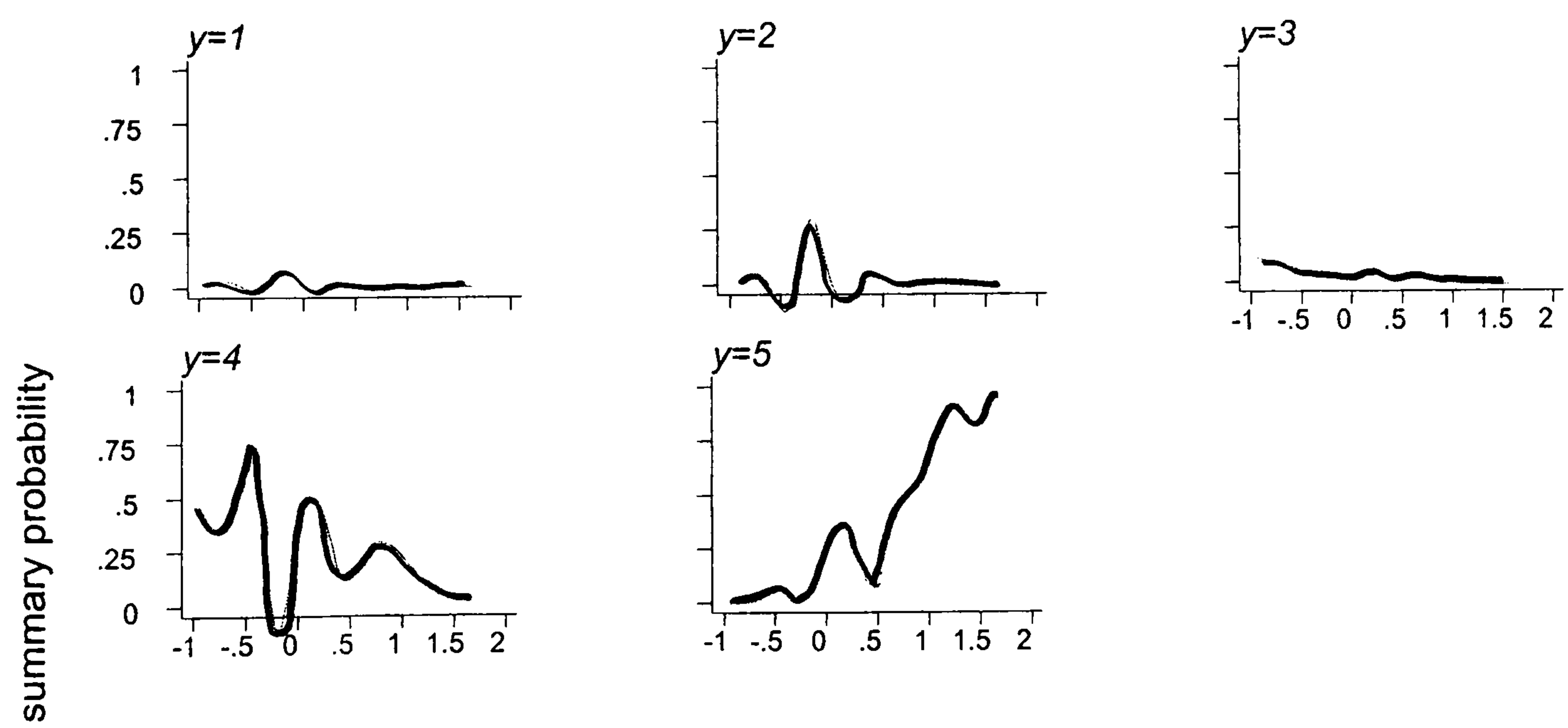
PANEL A: Effect of Use/Non-Use index on selection of preference ordering



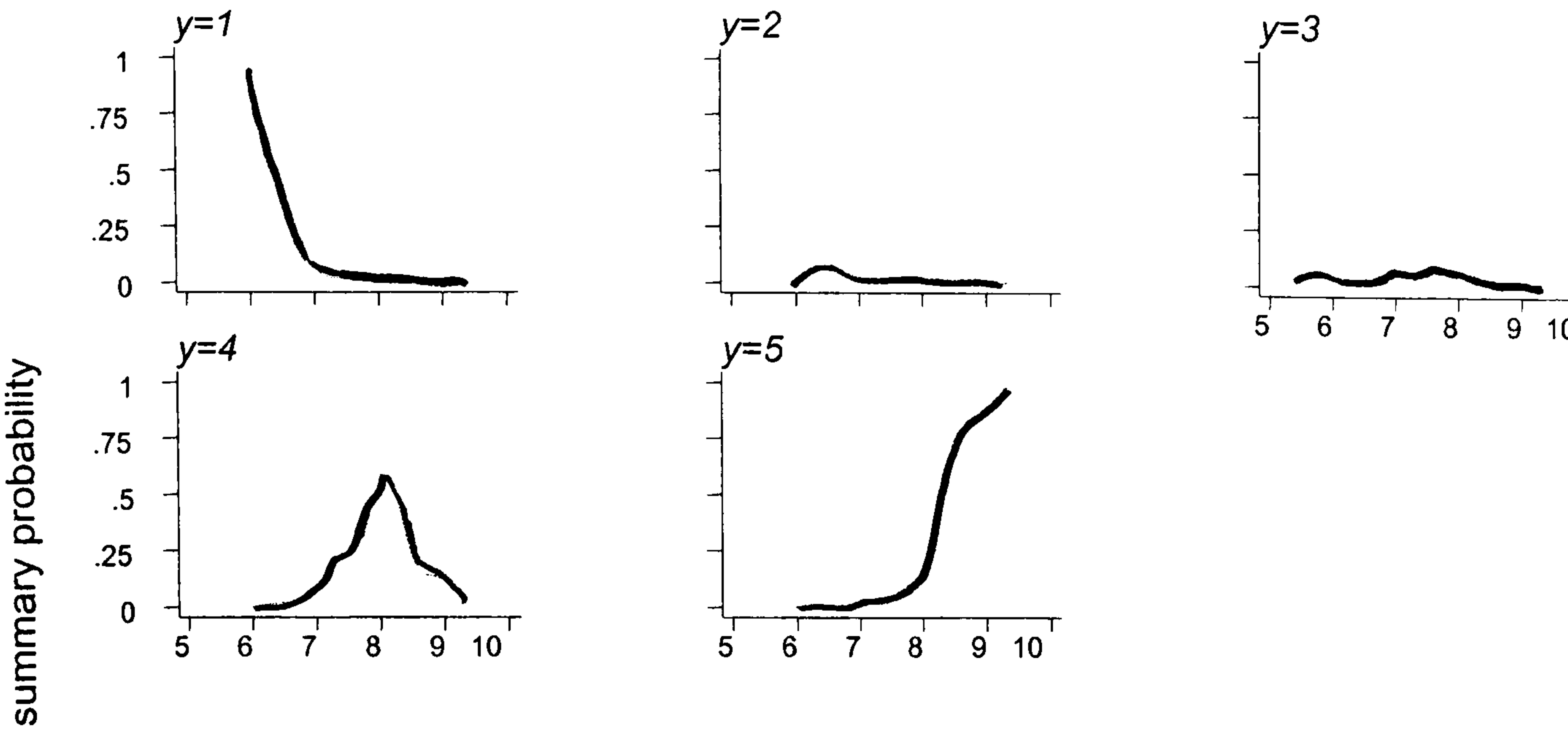
PANEL B: Effect of Animal Welfare index on selection of preference ordering



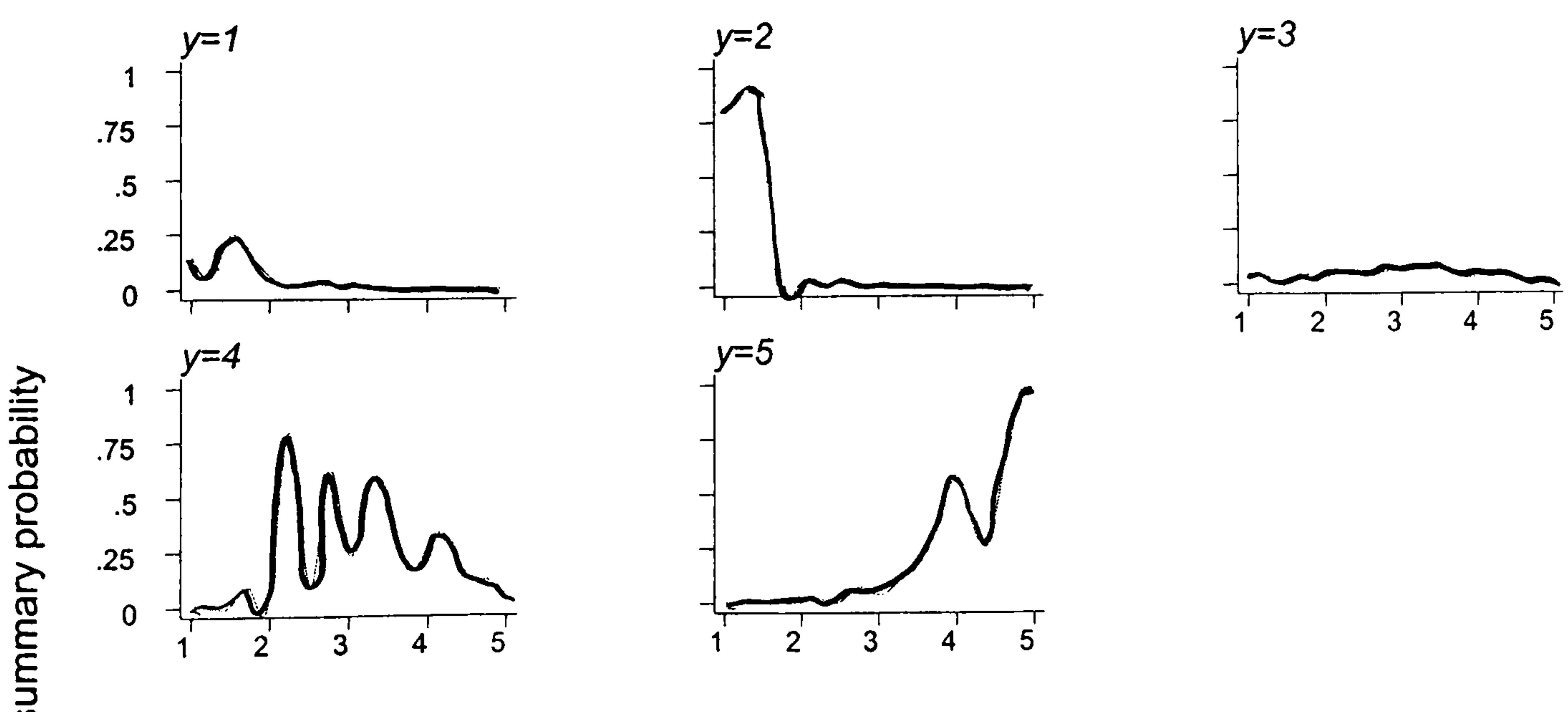
PANEL C: Effect of Sympathy index on selection of preference ordering



PANEL D: Effect of Ethics index on selection of preference ordering



PANEL E: Effect of Income on selection of preference ordering



PANEL F: Effect of Programme index on selection of preference ordering

5.16. Appendix 2 – Questionnaire

UCL UNIVERSITY OF LONDON	GIANT PANDA QUESTIONNAIRE	UNIVERSITY OF BEIJING

****Introductory Presentation

Hello! My name is .... and I work for the Universities of Beijing and London. We are conducting a survey about the conservation of the Giant Panda in China [show photo]. In particular, we want to find out how the public feels about alternative conservation scenarios for the Giant Panda. We would very much appreciate your cooperation by answering our survey. The questionnaire will last approximately 30 minutes. We would appreciate if you were to complete the survey together with me as I will be providing some useful information as we go along. All your answers are strictly confidential. You may choose to finish the interview at any time or not to answer particular questions. Lets start with section A...

A. General Environmental Attitudes

A.1) How interested are you in environmental issues

PLEASE CIRCLE THE APPROPRIATE NUMBER ON THIS SCALE:

1	2	3	4	5
Not interested at all				Very interested

99. Don't know

A.2) Please indicate how important you think the following environmental problems are, bearing in mind it would be using taxpayer's money to address each problem.

PLEASE CIRCLE ANSWER CODES:

	Very Important	*Of some Importance*	*Not Important*	*Don't Know*
Traffic congestion in the city you live in	1	2	3	99
Ozone depletion & Global Warming	1	2	3	99
Species extinction	1	2	3	99
Waste management	1	2	3	99
Water pollution of lakes and rivers	1	2	3	99
Air pollution	1	2	3	99
Destruction of forests	1	2	3	99
Less variety of plants and animals	1	2	3	99
Danger from nuclear power plants	1	2	3	99

A.3) How often does your family purchase *food* products that guarantee the *humane treatment of animals* (for example eggs from free-range chickens, dolphin-friendly tuna etc)?

PLEASE CIRCLE THE APPROPRIATE NUMBER ON THIS SCALE

1	2	3	4	5

99. Don't know

A.4) How often do you eat meat in a typical week?

PLEASE CIRCLE THE APPROPRIATE NUMBER ON THIS SCALE

Four times or more	1
Three times	2
Two times	3
Once	4
Never	5
Don't know	99.

A.5) How many animals do you keep in your home?

A.6) Would you be willing to wear a coat made from animal fur, if given one?

PLEASE CIRCLE THE APPROPRIATE NUMBER ON THIS SCALE

1 Definitely Yes	2	3	4	5 Definitely No

99. Don't know

A.7) Would you buy cosmetics tested on animals?

PLEASE CIRCLE THE APPROPRIATE NUMBER ON THIS SCALE

1	2	3	4	5

99. Don't know

A.8) Would you be willing to use medicine tested on animals?

PLEASE CIRCLE THE APPROPRIATE NUMBER ON THIS SCALE

1	2	3	4	5

99. Don't know

A.9) *Leghold Traps are used in hunting various animals world-wide. The animal is intended to step on the trigger of the trap, after which two metal jaws forcefully shut around its leg. The use of leg-hold traps is prohibited in over 60 countries, including the European Union.*

Would you support the ban on the use of leg-hold traps?

PLEASE CIRCLE THE APPROPRIATE NUMBER ON THIS SCALE

1 Certainly Yes	2	3	4	5 Certainly No

99. Don't know

A.10) Are you a *member or supporter* of any societies for the *humane treatment* of animals (for example the World Society for the Protection of Animals (WSPA), the Royal Society for the Prevention of Cruelty to Animals (RSPCA), American Society for the Prevention of Cruelty to Animals (ASPCA), People for the Ethical Treatment of Animals (PETA) etc.)?

PLEASE CIRCLE THE APPROPRIATE NUMBER ON THIS SCALE

1	2	3	4	5

99. Don't know

B. Giant Pandas in China

PRESENTATION
Now, I would to provide some information about the Giant Panda
Use visual aids
Points made clear to respondents:

- The Giant Panda only lives in the bamboo forest of South-West China.
- There are only 1000 Pandas left in the wild.
- Show decline of Panda population
- The main threat to the giant Panda is the destruction of its habitat by the local people, since they have no other way to make their living but to use the bamboo-forests for agriculture and grazing activities.
- Show decline of Panda habitat.

Please answer the questions in Sections B

B.1) Were you familiar with the extent that the panda population has declined?

Very Familiar	1
Somewhat familiar	2
Not familiar at all	3

B.2) Were you familiar with the threats the Panda population faces?

Very Familiar	1
Somewhat familiar	2
Not familiar at all	3

B.3) From which sources have you learned about pandas before this questionnaire?

PLEASE CIRCLE THE APPROPRIATE NUMBER

1. I saw them in the wild
2. I saw them in a zoo (Please, state where ....)
3. TV/cinema
4. Magazines/newspapers/books
5. School/ College
6. I saw them in a Panda breeding reserve.

B.4) Which are the *three* consequences of Panda extinction that worry you the most?

PLEASE CIRCLE THREE ANSWER CODES:

1. Loss of genetic material probably useful in the future
2. My children will never see a panda in the wild
3. I like pandas, I hate to think they will not be around anymore
4. Adverse effect on the environmental chain
5. A feeling of guilt
6. Panda's have a right to survive
7. Less species variety in the world
8. Other (Please state) ....
9. I am not worried about Panda conservation

99\. Don't know

C. Panda Conservation Programme

PRESENTATION

Points made clear to respondents:

- Out of the remaining 1000 pandas, 200 live in an area called the Wolong Nature Reserve. This area hosts the largest number of Pandas and is considered to offer the only realistic chance of saving the species.
- Still the Wolong reserve is under threat due to its use by the local people for agriculture and grazing activities.
- Note that the Panda is not hunted since there is no desire for its products. Also, note that the Panda population is not disturbed by tourists since all visits to Wolong are not allowed.
- Also, note that the Wolong Reserve also hosts many plants, mammals, birds and reptiles species but non of these are considered to be rare or under threat of extinction.
- The Chinese Government is considering to implement a new programme to save the Giant Pandas in Wolong called the Wolong Panda Conservation Program
- The aim of the programme is to increase the number of pandas in Wolong to 500 animals, which is considered by scientists to be sufficient for the conservation of the species.
- The Chinese Government is considering three different scenarios for the conservation of the Panda. Only one, if any, of the programmes will be implemented. The only difference in these scenarios is the amount of land or space offered to each Panda. All other characteristics of these three programmes will be the same.
    - Implementation of any of these three programmes will equally secure the maintenance of 500 Pandas and the definite long-run preservation of the species
    - Also, under all three scenarios it will still not be possible to visit Wolong to view Pandas.
- We would like to know how much each of these scenarios is worth to you.
- The Chinese Government will finance the Wolong Panda Conservation Program with an airport-tax surcharge on all international flight departures from China

Please bear in mind:

- Your available income.
- That if you were to be taxed for the conservation of Pandas, this might reduce your expenditures in other similar causes (environmental or not).

Scenario A: Captive Breeding
PRESENTATION

The first Wolong Panda Conservation Program that is contemplated will involve the following:
[Show Visual Aids]

Aim:	Captive Breeding within the existing Breeding center in Wolong that will sustain a Panda population of 500 Pandas
Living environment:	Zoo Cage
Space per panda:	$100m^2$ (1/100 of a hectare)
Total land required	500 X 100 m^2 = 50.000 m^2 (5 hectares)

C.1) The table below presents certain possible amounts that someone may be willing to pay in the form of an airport tax surcharge on all international flight departures from China in order to contribute to a Panda Fund that would finance the conservation program just described to you.

Please go through this table and tick the amount that corresponds to your maximum willingness to pay

US$	Tick your maximum willingness to pay ✓
0	
0.5	
1	
1.5	
2	
2.5	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
20	
21	
22	
23	
25	
27	
30	
35	
37	
40	
45	
50	
60	
75	
100	
Don't Know	

Scenario B: Breeding in Pens

The second Wolong Panda Conservation Program that is contemplated will involve the following:

PRESENTATION

The new Wolong Panda Conservation Program will involve the following:

Aim:	Captive Breeding within the existing Breeding center in Wolong that will sustain a Panda population of 500 Pandas
Living environment:	*Pen or garden*
Space per panda:	$5000m^2$ (half an hectare or the size of football/soccer pitch)
Total land required	$500 \times 5000\ m^2 = 2.5\ km^2$ (or 250 hectares)

C.2 The table below presents certain possible amounts that someone may be willing to pay in the form of an airport tax surcharge on all international flight departures from China in order to contribute to a Panda Fund that would finance the conservation program just described to you.

Please go through this table and tick the amount that corresponds to your maximum willingness to pay

Remind respondents of their:
- Available income.
- If taxed for the conservation of Pandas, this might reduce their expenditures in other similar causes (environmental or not).

Also respondents as to be asked to think "what this scenario was worth to them" irrespective of what they had stated in the previous WTP question.

US$	Tick your maximum willingness to pay ✓
0	
0.5	
1	
1.5	
2	
2.5	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
20	
21	
22	
23	
25	
27	
30	
35	
37	
40	
45	
50	
60	
75	
100	
Don't Know	

Scenario C: Panda Conservation in the Wild
The third Wolong Panda Conservation Program that is contemplated will involve the following:

PRESENTATION
So, the new Wolong Panda Conservation Program will involve the following:

Aim:	To sustain a Panda population of 500 Pandas in the wild
Living environment:	Natural Habitat
Space per panda:	$4km^2$ (400 hectares)
Total land required	500 X $4km^2 = 2000\ km^2$ (200.000 hectares)

C.3 The table below presents certain possible amounts that someone may be willing to pay in the form of an airport tax surcharge on all international flight departures from China in order to contribute to a Panda Fund that would finance the conservation program just described to you.
Please go through this table and tick the amount that corresponds to your maximum willingness to pay

Remind respondents of their:

- Available income.
- If taxed for the conservation of Pandas, this might reduce their expenditures in other similar causes (environmental or not).

Also respondents as to be asked to think "what this scenario was worth to them" irrespective of what they had stated in the previous WTP question.

US$	Tick your maximum willingness to pay ✓
0	
0.5	
1	
1.5	
2	
2.5	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
20	
21	
22	
23	
25	
27	
30	
35	
37	
40	
45	
50	
60	
75	
100	
Don't Know	

C.4) IF THE ANSWER TO ANY OF THE ABOVE WAS ZERO: What is the main reason why you are *not willing* to contribute to the Wolong Panda Conservation Programme? *PLEASE GIVE JUST YOUR MAIN REASON.*

....

....

C.5) How sure are you about the amounts you just accepted or refused paying?
PLEASE CIRCLE THE APPROPRIATE NUMBER ON THE SCALE:

	1	*2*	*3*	*4*	*5*
Very unsure					*Very sure*

99 – Don't know

C.6) Lastly, I would like you to consider the possibility that the last Wolong Panda Conservation Program would fall short of its goal and be able to sustain 300 instead of 500 Pandas in the wild. This would make the long-run conservation of the Panda highly uncertain but would secure the conservation of the Wolong habitat. This would benefit the other plants and animals that live in that habitat.

The table below presents certain possible amounts that someone may be willing to pay in the form of an airport tax surcharge on all international flight departures from China in order to contribute to a Panda Fund that would finance the conservation program just described to you.

Please go through this table and tick the amount that corresponds to your maximum willingness to pay

Remind respondents of their:

- Available income.
- If taxed for the conservation of Pandas, this might reduce their expenditures in other similar causes (environmental or not).

Also respondents as to be asked to think "what this scenario was worth to them" irrespective of what they had stated in the previous WTP question.

US$	Tick your maximum willingness to pay ✓
0	
0.5	
1	
1.5	
2	
2.5	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
20	
21	
22	
23	
25	
27	
30	
35	
37	
40	
45	
50	
60	
75	
100	
Don't Know	

D. Attitudes for Panda Conservation Programme

D.1) What kind of support do you think the Wolong Panda Conservation Programme would receive from foreigners visiting China?
PLEASE CIRCLE THE APPROPRIATE NUMBER ON THE SCALE:

	1	2	3	4	5
No support at all					*Very strong support*

99 - Don't know

D.2) Do you think that the airport tax increase described above is a fair method of financing the expenses connected with the implementation of the Wolong Panda Conservation Programme?
PLEASE CIRCLE THE APPROPRIATE NUMBER ON THE SCALE:

	1	2	3	4	5
Very unfair					*Very fair*

99 - Don't know

D.3) To what degree do you trust the capabilities of the relevant authorities to implement and enforce conservation measures for Giant Pandas if they have adequate funding?

PLEASE CIRCLE THE APPROPRIATE NUMBER ON THIS SCALE

1	2	3	4	5
Strongly trust				*Strongly distrust*

99. Don't know

D.4) If the Wolong Panda Conservation Programme would be implemented, do you think it would attain the desired conservation objective (e.g. sustaining a population of 500 Pandas)?

PLEASE CIRCLE THE APPROPRIATE NUMBER ON THIS SCALE

1	2	3	4	5
Definitely no				*Definitely yes*

99. Don't know

E. Personal information

REMEMBER: ALL QUESTIONNAIRES ARE TOTALLY ANONYMOUS

E.1) What is your sex?

1. Male 2. Female

E 2) What is your country of origin?

....

E. 3) What is your age group from the categories listed in the card bellow?
PLEASE CIRCLE THE APPROPRIATE CODE

Less than 20 years	1
20-30	2
31-40	3
41-50	4
51-60	5
61-70	6
Over 70	7

E.4) Are you:
PLEASE CIRCLE THE APPROPRIATE CODE

Single	1
Married/Living with someone	2
Divorced/separated	3
Widowed	4

E.5) How many people are there in your household, including yourself?

....

E.6) What is the highest level of education you have obtained?
PLEASE CIRCLE THE APPROPRIATE CODE

Primary school	1
High school	2
Vocational training	3
University/ College degree	4
Postgraduate degree	5
Other (please specify)	6

E.7) Which occupation or activity category do you fall into?

Employed full-time	1
Employed part-time	2
Looking after the home full-time	3
Student	4
Unemployed	5
Retired	6
Unable to work due to sickness or disability	7
Other (please specify)	8

E.8) Which of the following categories best fits your monthly household income after deductions such as tax, etc.
Remember that this information is strictly anonymous and confidential as is the rest of the questionnaire.

PLEASE ANSWER IN THE CURRENCY WITH WHICH YOU ARE MOST FAMILIAR

In UK Pounds (£)	
1. Less than £250	
2. £250-500	
3. £501-1000	
4. £1000-1500	
5. £15001-2000	
6. £2001-2500	
7. £2501-3000	
8. £3001-3500	
9. £3501-4000	
10. £4001-5000	
11. £5001-6000	
12. £6001-7000	
13. £7001-8000	
14. £8001-9000	
15. £9001-10000	
16. More than £10000	

INCOME CARDS ALSO PROVIDED IN:

In US Dollars (US$)	Japanese Yen	German Marks

E9) How long will you be staying in China?

....

E.10) How many times have you visited China before?

1. This is my first time
2. I have visited China .... times in the past.

E.11) Are you on a package holiday?

Yes	1
No	2

Price of Package: ....

E.12) If not on a package trip to China, please provide an estimate of the total cost of your holiday

Air-ticket ....
Hotel ....
Other ....

E.13) At which hotel are you staying?

....

E.14) What is the *main* purpose of your visit?

	1
Business	2
Educational	3
Other	4

E.15) How important were the following features in attracting you to China?

PLEASE CIRCLE ONE NUMBER ONLY

	Very Important	Of some Importance	Not Important	Don't Know
Chinese culture and history	1	2	3	99
Shopping	1	2	3	99
Environmental sites of China such as	1	2	3	99
Entertainment and night-life.	1	2	3	99
Food	1	2	3	99
Hotel Services	1	2	3	99

E.16) How likely do you think you might visit China again?

1	2	3	4	5
Highly Likely				Highly Unlikely

99. Don't know

E.17) Lastly, what did you think of this questionnaire?
PLEASE CIRCLE THE APPROPRIATE ANSWER CODES:

1 - Interesting
2 - Boring
3 - Too long
4 - Difficult to understand
5 - Partial

Thank You For Taking Part In This Survey!

CHAPTER SIX

Non-Market Valuation in Environmental Damage Assessment The US Experience and The Proposed EU Directive

CHAPTER SIX

Non-Market Valuation in Environmental Damage Assessment
The US Experience and The Proposed EU Directive

6.1. Introduction

Non-market valuation techniques have infiltrated all three main fields of environmental decision making: policy and investment evaluations, regulatory reviews, and natural resource damage assessments.[1] The proliferation of these tools in the first two of these fields (policy and regulatory evaluation) has been witnessed both in the US and several EU countries (though with substantial differences and to varying degrees).[2] This is reflected both in the statutes (where in certain countries some form of valuation or cost-benefit analysis is required by law) but even more so in the day-to-day practice of environmental decision making, where valuation is not legally required but nevertheless is widely used by policy makers and regulators. In contrast, the utilisation of valuation tools for natural resource damage assessment (NRDA) purposes has only become widespread in the US, while no such tradition of taking 'valuation to court' exists in EU countries. Yet, the proposed EU Environmental Liability Directive is likely to pave the way for the use of economic assessment tools in European courts. This concluding chapter seeks to assess the US experience with using non-market valuation in courts with the aim of providing suggestions as European legislators formulate the direction of the EU environmental liability regime. The aim is not to offer a comprehensive discussion of all the technical, methodological and legal issues that have been raised.[3] Instead, the contribution of this chapter is that it identifies and discusses an eclectic set of fundamental issues that are argued to be of most importance for the use of valuation in courts.

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[1] Economic valuation of natural resources is also relevant for environmental costing and green national accounting. Navrud and Pruckner (1997) and Pearce (2000) provide comparisons of the various uses of valuation.

[2] The discussion includes countries not part of the EU but members of the European Economic Area (such as Norway).

[3] Nor it is the aim of the paper to focuses on examining conceptual and philosophical issues for applying valuation in *policy* appraisal. For a review of these issues see Bromley and Paavola (2002).

The following section classifies various methods of economic assessment tools that have or can be used in courts. Section 6.3 assesses the US experience of allowing valuation tools in courts. Both the current statutes and practice with respect to using economic valuation tools in courts are reviewed. Section 6.4 discusses the new EU White Paper on Environmental Liability. The implications for using valuation in European courts are explored. Section 6.5 presents certain legal issues that have pre-occupied both academics and the courts in the in the US. Lessons for the new EU environmental liability directive are drawn. The final section summarises the issues and provides recommendations for future research on the application of valuation in damage assessment.

6.2. Economic Damage Assessment Methods.

Economic valuation methods for assessing environmental damages can be split into formal valuation methods and environmental pricing techniques.[4] The former are used to assess standard (neo-classical) welfare measures (such as consume surplus) while the latter focus on market prices that are assumed to reflect economic scarcity. A substantial part of the deliberations in many environmental liability cases in the US have centred around the differences between pricing/costing and valuation techniques. For example, in the American Trader oil spill case the defence brought the very concept of 'consumer surplus' into dispute and argued that reliance on existing market price and cost data would suffice for a decision on damages to be reached.[5] It is thus useful for the subsequent discussion to elaborate on why economists have argued that pricing techniques do not provide adequate measures of the welfare loss experienced by society from damages to environmental resources.

Valuation techniques are classified into revealed and stated preference techniques. *Revealed preference* valuation techniques (including travel costs and hedonic pricing) rely on information from individual consumption/ purchasing behaviour occurring in markets related to the environmental resource in question (surrogate markets). The price differential of the good (purchased in the surrogate market), once all other variables that affect choice apart from

[4] For an introductory discussion of these techniques see Navrud (2000), Bateman (1999), Freeman (1993) and Dixon *et al* (1988).

environmental quality have been controlled for, will reflect the purchaser's valuation of that particular level of environmental quality. These methods have the appeal of relying on actual/observed behaviour but their main fundamental drawbacks are the inability to estimate non-use values[6] and the dependence of the estimated values on the assumptions made on the relationship between the environmental good and the surrogate market good.[7,8] *Stated Preference* techniques (including contingent valuation, choice experiments, and contingent ranking) are used in situations where both use and non-values want to be estimated and/or when no surrogate market exists from which environmental (use) value can be deduced. These techniques use questionnaires to develop a hypothetical market through which they elicit values (both use and non-use) for the environmental good under investigation. Stated preference techniques do not suffer from the same technical limitations as revealed preference based approaches and can also be applied to non-use values. Yet, the hypothetical nature of the market constructed has raised numerous questions regarding the validity of the estimates (Navrud, 2000).

Three categories of *environmental pricing techniques* have been commonly used. The first method relies on the use of market prices of directly related goods and services as surrogate values for environmental amenities. The quality of the environmental good is treated as an input into the production function of various goods and services (outputs). Changes in these environmental inputs may lead to changes in productivity or production costs which, in turn may lead to changes in prices and output levels which can be observed and quantified (Dixon *et al.,* 1988). These approaches have been referred to as 'dose-response' techniques.[9] The

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[5] See Chapman and Hanemann. (2000) for a detailed account of these arguments between the legal defence and the economists which were acting as expert witnesses in this case.

[6] See Larson (1992) for an alternative view.

[7] See Freeman (1993) for a thorough discussion.

[8] Revealed preference valuation methods are also inadequate when we wish to assess environmental quality changes outside the observed range.

[9] Three such techniques have been widely used: 'changes-in-productivity' approaches where impacts on environmental quality are reflected in the changes in the productivity of the systems involved and these, in turn, are used to assign values. The physical changes in productivity (e.g. crop yield) are valued using market prices for inputs and outputs. *'Loss of earnings'* approaches measure the impacts on environmental quality from changes in human productivity. The value of lost earnings and of medical costs created from the degradation in the quality of some environmental resource (e.g. water poisoning) is used under such approaches as a proxy for environmental value. *'Opportunity cost'* approaches are based, as the term suggests, on the concept of opportunity costs: the value of using an environmental resource for a particular purpose is approximated with the value in forgone income from alternative uses of that resource. (see Dixon *et al* (1988) and Freeman (1979) for a detailed exposition of such approaches).

second set of pricing techniques relies on data from *actual* costs of maintaining or preventing environmental degradation as a proxy for environmental value.[10] The third set of pricing methods is similar to above but relies on *potential* (as opposed to actual) costs as proxies for environmental value. These include methods as such *'shadow-project appraisal'*.

Valuation and pricing techniques both rely in individual preferences (through hypothetical or surrogate markets or through price information). Yet, economists have argued that the latter do not capture total social net value of damages. Cummings (1991) has shown that the market prices used by US courts since the 1950's do not accurately reflect economic values. He argues that violations of the assumptions of perfectly competitive markets and mobility of agents are the root of the problem. Hanemann and Keeler (1995) have further shown that even without such violations, market prices fail as a measure of value for *non-marginal* changes in environmental resources. This has been understood by economist since Hotelling's exposition of how the correct measure of value for non-marginal changes in the allocation of market goods is the change in consumer surplus. This is given by the area under two demand curves or equivalently by people's willingness to pay for reduced damages (or the willingness to accept to tolerate these damages). WTP to prevent damage may be larger, smaller or equal to estimates from pricing or maintenance cost techniques. For marginal changes or for goods that are perfectly divisible market prices work adequately as measures of welfare. When one uses market prices to measure the marginal value for a divisible market good, heterogeneity in preferences becomes irrelevant, and aggregation is trivial. At the margin, all consumers who face the same price have the same marginal value, regardless of their preferences, income or other commodity or individual attribute. All that the courts needs to know about peoples marginal value of the good is provided in the market price. There is no need for further knowledge about the actual demand curve. In addition, since all individuals have the same value at the margin, aggregation of marginal value across consumers is relatively simple. This is not so for non-divisible goods with non-marginal changes. In this case knowledge of the demand curve is required in determining individual welfare changes and preference

[10] This set includes *'cost-effectiveness'* analysis where a predetermined goal or objective regarding the quality of an environmental asset is set and then the most cost effective means of achieving it are chosen and *'preventive or mitigation expenditure'* approaches where the value of an environmental recourse is approximated by the cost of the preventive measures that people are willing to pay to avoid any damage to it or from the cost savings obtained from a reduction in maintenance cycles due to reduced damage rates.

heterogeneity becomes important in obtaining aggregate welfare estimates (Hanemann and Keeler, 1995).

6.3. Natural Resource Damage Assessment in the US

Having briefly compared valuation and pricing/costing methods of damage appraisal and discussed why economists have argued in favour of the former, we now turn to review how and to what extent such methods have infiltrated US courtroom and in NRDA procedures.

US statutes and economic valuation of environmental damages

Compared to the EU, the US legal system has more readily incorporated the use of individual preference based methods in assessing damages to environmental resources. In the US public natural resources such as the atmosphere, oceans, estuaries, rivers, and plant and animal species are public trust resources. The main federal statutes containing provisions establishing management agencies as trustees of natural resources are the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA or more commonly known as Superfund) [11], the Oil Pollution Act of 1990 (OPA), and the National Marine Sanctuaries Act of 1996 (NMSA).[12] Under these acts designated trustees are to assess and recover damages to resources resulting from injury to natural resources (such as from an oil spill or from the release of a hazardous substance). Federal trustees include the Department of Interior (DOI) and the National Oceanic and Atmospheric Administration (NOAA). The statutes also acknowledge various State or local governments and Native American Tribes as trustees.

Under all three statutes mentioned above, natural resource damage claims are based on the restoration of public resources and have three basic components. The measure of damages is (1) the cost of restoring, rehabilitating, replacing, or acquiring the equivalent of the damaged natural resources (primary restoration); (2) the diminution in value of the natural resources pending recovery of the resource to baseline, but-for the injury (interim lost value); and (3) the reasonable cost of assessing those damages. The first component provides for restoration of injured resources to their baseline level. The second component compensates the public for

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[11] CERCLA was amended by the Superfund Amendments and Reauthorization Act (SARA) in October 1986. The SARA encouraged greater citizen participation in making decisions on how sites should be cleaned up.

[12] Apart from the CERCLA, OPA and NMSA trustees can currently sue for environmental damages under the Clean Water Act of 1972, the Superfund Amendments and Reauthorization Act of 1986, the Deepwater Port Act of 1996, the Trans-Alaska Pipeline Act of 1973 and the Outer Continental Shelf Lands Act of 1953. Some state

reductions in the value of resource services pending recovery of the injured resources. (Penn. 2000). Moreover, the 1989 case of Ohio Vs. US Department of Interior motivated by the Exxon Valdez Oil spill granted equal weight to use and non-use values (NUVs) in damage assessment. The allowance of NUVs in the scope of damages implies the use of stated preference techniques since these were (and generally still) considered the only feasibly method of estimating such values.[13] Further individual preference based valuation techniques (including CV and travel cost methods) were given "rebuttable presumption" which implies that US legislators found that preference based methods of valuation were reliable and the best available techniques for quantifying natural resource damages (Loomis, 2000). Defendants can appeal the specific application of these methods but not the methods in general.[14]

Various industries and stakeholder groups fiercely opposed the use of stated preference-based techniques and especially the use of the CV method for estimating non-use values. This criticism manifested itself in academic journals, workshops but also in the courts.[15] As a response to these attacks the Department of Commerce convened a panel consisting of leading economists (including the Nobel prize Laureates Robert Sollow and Kenneth Arrow) to assess the validity of the CV method and the measurement of non-use values. The resulting 'NOAA panel' cautiously supported the use of stated preference techniques in damage assessment cases (see Arrow *et al.,* 1993).[16] They concluded that information provided by stated preference techniques is as reliable as marketing analysis of new products and damage assessment normally allowed in court proceedings. A stringent list of guidelines were

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laws also allow damage recovery and provide various types and levels of coverage (see Breedlove, 1999 for more details).

[13] Shavell (1993) notes that the possible uses of stated preference techniques in litigation can extend beyond damage assessment but may in principle be used for (a) the determination whether a party who has caused harm to a natural resource is liable for negligence (where liability is based on negligence rather than strict liability). Shavell explains this arguing that determination of negligence requires assessment of the magnitude of possible harm and it is for the latter purpose which stated preference techniques could be useful; and (b) the assistance in calculating the degree of cleanup required of a party responsible for harm to a natural resource. This is so because the value of the resource will affect the amount that is rational to spend on cleanup (Shavell, 1993, p.373).

[14] The rebuttable presumption status of preference based techniques was attacked by industries, yet both the US Court of Appeals (US Court of Appeals, 1989) and Department of Interior (DOI 1991) found that preference techniques to be reliable for estimating both use and non-use values.

[15] See for example the debates in the edited volume by Hausman (1993) and between Diamond and Hausman (1994), Hanemann (1994) and Portney (1994) in the special issue of the *Journal of Economic Perspectives*.

[16] The panel concluded "that CV [contingent valuation] can produce estimates reliable enough to be the starting point of a judicial process of damage assessment, including lost passive-use values." (Arrow *et al.*, 1993).

recommended to assure reliably and validity, but from this point forwards NUVs and CV techniques have been allowed in US court proceedings.[17]

[17] See Harrison (2002) for a critique of these guidelines.

Court-room experience with economic valuation techniques

Probably the most publicized case using the CV methodology concerned the Exxon Valdez oil spill off the shores of Prince William Sound in the State of Alaska. The damages were estimated to lie between \$3 and \$15 billion (Carson *et al* 1994). Exxon settled out of court by agreeing to pay a total of US\$1 billion. In the Montrose damage assessment, which settled recently, trustees used a CV to assess the value of impacts due to DDT contamination off the coast of California, and recovered the value of interim losses (Penn, 2000). Other examples of the successful use of CV techniques for the estimation of environmental damages include the State of Colorado's case quantifying the damage caused to watersheds by the Eagle Mine (see Kopp and Smith, 1989), and the State of Washington's case quantifying the damages from an oil spill that soiled the coastline of the State of Washington (see Rowe *et al.*, 1992). In both these cases the trustees estimated both use and non-use values. Finally, the American Trader Case is one of the few examples of the application of these valuation techniques that was not settled out of court; there the trustees estimated the damages from an oil spill to the affected coastline using the benefit transfer method (see Chapman and Hanemann, 2000).[18]

Evolving approach to economic valuation of environmental damages in the US

The implementation of the NOAA NRDA guidelines has altered significantly over time. In particular, a shift in emphasis occurred in the mid-1990s, with respect to approaches to determining the scale of compensatory restoration. In the early 1990s, economic assessments of natural resources damage were conducted with the objective of determining a money value of damages that, if paid as compensation, would make the public whole again. Since the mid-1990s the procedures for NRDA, and the applicable legislation, have shifted towards resource compensation and the resource-to-resource (or service-to-service) approaches to determining the scale of compensatory restoration. The guidelines suggest that the service-to-service approach is used when the injured and replacement resources and services are of the same type, quality, and of comparable value. It is similar to in-kind trading between the injured and replacement resources and services. The defendant is allowed to substitute "equally valued" replacement resources for the injured ones.

The scaling analysis (i.e. the determination of the size of compensatory restoration) simplifies to selecting the scale of a restoration action for which the present discounted quantity of replacement services equals the present discounted quantity of services lost due to the injury.[19, 20] Also, monetary valuation procedures are still to be used when there are no appropriate compensatory restoration options and when the injured and restored resources and services are of comparable type, quality, but not value (MacAlister *et al.,* 2001).[21] Finally the latest NRDA guidelines allow the use of valuation techniques in order to show that the costs of primary restoration may be grossly disproportionate to the benefits. If this is shown then incomplete primary restoration may be permitted. The responsibility for demonstrating this rested with the party responsible for the damage (Penn, 2000 and MacAlister *et al.,* 2001.[22] Therefore, although the movement within the US has been toward the substitution of replacement resources for injured ones, there remains a role for valuation in assessing the degree of substitutability between the two resources.

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[18] See Loomis (2000), Hanemann (1992), Ward and Duffield. (1992), and Breedlove (1999) for more examples of the use of preference based techniques in US legal damage assessment cases.

[19] To determine the scale of compensatory restoration in practice, a number of parameters have to be identified. The services lost due to the injury are quantified by defining the time of the injury, the extent of the injury, the reduction in resources and services from baseline, and the trajectory of recovery back to baseline. The parameters that define the benefits of restoration include when the restoration project begins, the time until the project provides full services, the productivity of the project through time, and the relative productivity of the created or enhanced resources and services compared to the injured resources and services. A discount rate is applied in quantifying the lost and replacement services because the services occur in different time periods and they are not comparable otherwise. Without identifying these parameters, it would not be possible to determine how much compensatory restoration is required to make the public whole.

[20] Unsworth and Bishop (1994) have proposed a variant of the service-to-service approach for natural resource damage assessment. The habitat version of the approach, habitat equivalency analysis, has been applied in a number of damage assessment cases and has been largely accepted by the responsible parties. This approach is particularly suitable when dealing with modest injuries to homogeneous resources and thus scaling is a relatively straightforward matter. Unsworth and Bishop (in Randall, 1997) dealing with acres of damaged wetlands, assume that restored wetlands will be homogeneous to injured wetlands and, from that point, scaling is largely a matter of determining the time-path of resource recovery and applying the appropriate discount rate. For larger and more complicated injuries, methods such as choice experiments are appropriate. However, it has been recognized (e.g. MacAlister et al (2001)) that such methods, while promising, have yet to be validated in large-scale application under litigation conditions.

[21] For full details of the NRD assessment process recommended by the OPA see http://www.darcnw.noaa.gov/opa.htm

[22] In some circumstances, the "value-to-cost" variant of the valuation approach may be employed. Value-to-cost is only appropriate when valuation of the lost services is practicable but valuation of the replacement natural resources and services cannot be performed within a reasonable time frame or at a reasonable cost. With this approach, the restoration is scaled by equating the cost of the restoration plan to the value (in dollar terms) of losses due to the injury. The value-to-cost approach is equivalent to the framework for compensation prescribed by the CERCLA damage assessment regulations (Penn 2000).

6.4. Natural Resource Damage Assessment in the EU

The environmental liability regimes within EU member states make very limited provision for assessment of environmental damages, and few of them have made any progress in delineating the role of individual preference based techniques in estimating these. Most liability-type legislation found in member states deals with "traditional" types of damage, such as personal injury, or property damage, rather than with environmental damage *per se*. Moreover, such damages have been assessed with pricing/costing techniques and not valuation tools. For example the German Environmental Liability Act of 1990 and the Danish Compensation for Environmental Damage Act of 1994 are drafted in this spirit. In Belgium the courts are using a concept of 'collective goods' similar in spirit to that found in the US NRDA so that ecological and aesthetic loss can be compensated. Though in some other national laws, impairment of the environment is also covered, next to traditional damage, hardly any rules are given to specify this notion. Also there is no clear treatment of the role of economic valuation in assessment of damages.[23]

The recent White Paper on Environmental Liability (Com (2000) 66) seeks to fill this legislative vacuum and to broaden the notion of damages to cover that to biodiversity (in addition to damages in the form of contamination of sites and traditional damages which are covered by the environmental liability laws in most member states).[24] The document is a recognition of the 'pan-European' nature of the effects of pollution and for the need for legislation on environmental liability that transcends national borders. It aims at furthering the implementation of key environmental principles defined in the main EU Treaties (primarily the polluter pays, prevention and precautionary principles) and of existing EC environmental laws, at ensuring decontamination and restoration of the environment, integrating

[23] Here we will focus on discussion the use of valuation in the EU as a whole and not as applied in its member states. See the report by McKenna and Co (1996) for a review of the environmental liability regimes in 19 European countries.

[24] For subsidiarity reasons, the planned directive shall only be a framework directive that will contain minimum requirements. That means that it should be binding as far as the objectives and results are concerned, but the choice of the ways and instruments to achieve them should be left as much as possible to the Member States. For an analysis of the White paper see Holzman (1998) and background papers commissioned by the EU at http://www.europa.eu.int/comm/environment/liability/background.htm and http://europa.eu.int/comm/environment/liability/followup.htm.

environmental issues into other policy areas and to improve the functioning of the internal market. In addition, it explores various ways to shape an EU-wide environmental liability regime so as to further widen EU environmental objectives addressed in the EC treaty. Further it has opened the way for the inclusion of valuation methods to determine damages (in addition to market prices) in the statutes of the emerging EU environmental liability system.[25, 26]

The White Paper aims for making the "causer" of environmental damage (the polluter) to pay for remedying the damage that she has caused. Under the suggested directive, liability is only effective where polluters can be identified, damage is quantifiable and a causal connection can be shown. It is therefore not suitable for diffuse pollution from numerous sources (such as transboudary pollution). Moreover, the proposed liability scheme aims to enhance incentives for more responsible behaviour by firms and thus exert a preventive effect. The scheme seems to be motivated for a desire for setting efficient price signals. In these respect the White Paper is similar to the current US legal environmental liability setting. Yet, two notable differences concern the nature of the 'trustees' and the scope to which the regimes apply. In contrast to the US, the proposed EU liability system allows for environmental organisations and other interested parties to act as 'trustees' and pursue legal actions (see section 4.7 of COM (2000) 66). This has been rendered necessary in order to be able to challenge possible procrastination or negligence on the part of state authorities.[27] Yet, such provisions raise serious theoretical and practical issues particularly when non-use values are to be estimated (see section on

[25] The background of the White paper includes a Commission Green Paper in 1993, a European Parliament Resolution asking for an EC directive, opinions from the EU the Economic and Social Committee and Committee of the Regions and a Commission decision (in 1997) to produce a White Paper. Moreover, several Member States have expressed support for Community action in this field, including some recent comments on the need to address liability relating to genetically modified organisms (GMOs). Finally, interested parties have been consulted throughout the White Paper's preparation.

[26] The main features of the regime have been identified as: no retroactivity (application to future damage only); coverage of both environmental damage (site contamination and damage to biodiversity) and traditional damage (harm to health and property); a closed scope of application linked with EC environmental legislation: contaminated sites and traditional damage to be covered only if caused by an EC regulated hazardous or potentially hazardous activity; damage to biodiversity only if protected under the Natura 2000 network; strict liability for damage caused by inherently dangerous activities, fault-based liability for damage to biodiversity caused by a non-dangerous activity; commonly accepted defences, some alleviation of the plaintiffs' burden of proof and some equitable relief for defendants; liability focused on the operator in control of the activity which caused the damage; criteria for assessing and dealing with the different types of damage; an obligation to spend compensation paid by the polluter on environmental restoration; an approach to enhanced access to justice in environmental damage cases; co-ordination with international conventions; financial security for potential liabilities, working with the markets.

standing below). Also, the scope to which the Liability directive is to be applied seems much more limited than that in the US. The EU White Paper specifies that damages to biodiversity are to be covered only if protected under the Natura 2000 network. The network was established as one of the key objectives of the EU Habitats Directive on the conservation of natural habitats and wild flora and fauna (Directive 92/43/CEE, Directive 97/62/CE). The Habitats Directive created a European ecological network of special areas of conservation called Natura 2000 (article 3). Natura 2000 is to guarantee the maintenance (or reestablishment) of a favourable conservation status of habitats or the habitats of species in their natural range within the territory of the EU (article 3). It must be stressed that Natura sites do not cover all natural resources that could be potentially covered by a EU liability regime. For example there are sites that fall under the Habitat and Bird Directives but are not included in Natura 2000. The EU may thus wish to expand its liability system to cover a broader range of publicly owned natural resource.[28]

Regarding the use of valuation tools the White Paper paves the way for using valuation both when damages are irreparable[29] but also when damages are reparable but a cost- benefit assessment is required to avoid that disproportionate costs are spent on the restoration of such damages.[30] In cases where the costs of restoration are below the estimated value of the damaged natural resource, the new regime specifies that the compensation to be paid by the liable party should amount to the costs of restoration. Yet, in cases where the costs of restoration are considerably higher than the estimated value of the damaged natural resource, the compensation to be paid should amount (at least) to the value of the damaged natural resource while the awarded damages must be utilized for providing environmental services of equivalent quality and quantity of those lost.[31]

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[27] See the report by the EU Economic and Social Committee (CES, 2000) for details.
[28] There are also efforts to include a wide range of marine biodiversity species in NATURA 2000.
[29] "Economic valuation of biodiversity damage is of particular importance for cases where damage is irreparable" (Com (2000) 66).
[30] "Restoration of damage is feasible, there also have to be valuation criteria for the damaged natural resource, in order to avoid disproportionate costs of restoration. A cost–benefit or reasonableness test will have to be undertaken in each separate case." (Com (2000) 66).
[31] On this the White Paper states that "If restoration is technically not or only partially possible, the valuation of the natural resource has to be based on the costs of alternative solutions, aiming at the establishment of natural resources equivalent to the destroyed natural resources, in order to re-establish the level of nature conservation and biological diversity embodied in the Natura 2000 network."

Note that providing either monetary or equivalent resource compensation equally involves trade-offs and substitution between resources which in turn implies the use of valuation techniques. Also acquiring 'equivalent' resources is not always feasible. For instance, in densely populated areas it might be difficult to buy acres of wetlands because most land is already privately owned so its acquisition is impossible or too costly. Hence, some form of monetary compensation would be a reasonable alternative and the use of economic valuation would be required. The amount awarded should reflect the nature and significance of the damage to natural resources, including the loss of services. Further, the document states that a "minimum threshold for triggering the [liability] regime" must be determined such that "only significant damage should be covered". Economic valuation tools thus become relevant in determining such thresholds and when damages are significant.

The document endorses the use of revealed and stated preference techniques but it is cautious about the costs involved in undertaking original on-site studies. Thus, the development of the benefit transfer method is encouraged. To this aim, the importance of developing data banks with economic values for inferring natural resource damages (such as the Environmental Valuation Resource Inventory (EVRI)) is stressed (COM (2000)66). Interestingly, the White Paper does not question the validity of valuation tools but merely raises concerns over the costs of original studies. Its embracing of the benefit transfer method implies that it considers economic valuation techniques to provide accurate measures of environmental damage. The instigation of the use of valuation and the implied confidence in stated and revealed and preference methods stands in slight contrast to the latest US NRDA guidelines.

Thus, the White Paper is advocating the broad based use of, and exclusive reliance upon, valuation methods to an extent that now exceeds its level of application in the US. Whereas the US has begun to use "in kind" methods of compensation, the EU is looking to rely on a more comprehensive and carefully engineered approach to successive valuation. Does this make sense? What are the problems with the valuation approach that has resulted in the US turning to "in kind" methods? We turn to these issues in the next sections.

6.5. Should valuation be used in courts?

Despite the introduction of economic values in the US legal framework of environmental liability, the debate goes on regarding the legal validity or compatibility of using economic values for the determination of damages. Only an eclectic review of some of these issues is provided in this section. Issues of measurement and analysis are not addressed and neither are various fundamental conceptual, moral and philosophical issues that are more pertinent to the debate of whether valuation should be used for policy appraisal purposes. Instead we limit the discussion to issues that we believe have dominated the debate over using valuation in courts in the US. An attempt is made to show how these issues are equally relevant for the formation of the emerging European environmental liability regime.[32]

6.5.1. The debate over accuracy

Many objections to the use of valuation in courts have focused on measurement issues. Measurement issues concern two aspects of the problems concerning the accuracy of stated preference studies (such as CVs). One aspect is the *credibility* of the stated preferences, i.e. how well do the surveys create incentives for the truthful revelation of preferences? For example, if an individual wishes to skew the results of the exercise, does the methodology create incentives or mechanisms that will constrain this sort of behaviour? These are the problems of survey design that exist in all sorts of similar exercises (such as marketing studies). Extensive laboratory and field research has examined conditions under which CV surveys could in fact produce incentives for truthful revelation (Carson, Groves, and Machina, 1999). In addition numerous methods for externally and internally validating the results from stated preference studied have been developed (see Carson *et al.* 2001; Batmen et al. 2003; Bateman and Willis, 1999) Thus, the credibility of the results of a survey are a function of the quality of the survey design and analysis.

[32] Measurement issues (e.g. treatment of biases, validation, analysis etc.) are thoroughly discussed in Bateman *et al.* (2003), Bateman and Willis (2000) and Haab and McConnell (2002). Conceptual, philosophical and moral issues mainly concern the concept of value as applied to environmental resources (e.g. lexicographic preferences, 'nature' as the object of choice etc.) and the moral validity of using valuation techniques. See Kontoleon *et al.* (2002), Bromely and Paavola (2002), and Pearce (2000) for contemporary reviews.

The other problem of accuracy concerns the margin of error surrounding the valuation. This variance will depend to some extent on the size of the sample and the nature of the good being valued, but it will necessarily remain fairly large and uncertain on account of the technique that is used. This is of course true when valuation is used in cost benefit analyses generally, and not just in courtrooms. However, some have argued (e.g. Desvousges *et al* 1993, Johnson *et al* 2001) that damage assessment in courtrooms requires a much higher degree of accuracy than that required for policy and regulatory reviews. Errors in welfare estimates for policy purposes may or may not influence realised outcomes, and (if they do) the realised benefit and costs are usually distributed widely across many gainers and losers in the population. In contrast, the damages estimated in a court proceeding might be borne by a single or a few responsible parties. This concentration of impact renders the range of variability, and its relative uncertainty, more objectionable in the case of courtroom applications.

6.5.2. The issue of the costs of valuation.

The second point of concern has to do with the costs required to undertake a 'state-of-the- art' valuation exercise. Some have argued (e.g. Shavell, 1993) that in many cases the cost of undertaking the study may exceed the damage itself and thus valuation may not pass a cost-benefit analysis itself. The White Paper has recognised that original valuation studies may be too costly and strongly endorses the use of benefit transfer techniques. Yet, economists have stressed that benefit transfer, even if suitable for policy decisions, may lack the sufficient accuracy required for awarding damages.[33] Moreover, the White Paper suggests that only "significant damages should be covered" under this new regime. This suggests that there should be a *de minimis* standard before economic valuation is applied. But when will this be reached? Since most nonuse values will appear small from all tangible perspectives, it is difficult to know when a valuation approach would be applied, or how to create a standard that would authorise one. Finally, the documents also recognises the need for the development of a European data bank of environmental values. This is a recommendations in the right

[33] For recent discussions of the issues and findings concerning the accuracy of benefit transfer see Brouwer and Spaninks 1999; Moran and Pearce, 2001; Navrud 2002; Navrud and Pruckner 1997; Piper and Martin. 2001; Ready, 2002; Ready and Henken 1999; Rosenberger and Loomis, 2001; and Smith et al. 2002.

direction if benefit transfer is to be used, since transferring results from US studies to European cases is questionable.

6.5.3. Is Valuation Consistent with Compensation?

Several legal theorists in the US have examined the extent to which damages calculated using CV techniques correspond to ordinary legal definitions of compensable damage and loss. They argue that, although the *ex ante* use of preference based values for the determination of benefits may be valuable for policy decisions, it does not follow that it is equally useful or desirable to use these methods *ex-post* for the measurement of damages. According to Daum (1993) the model of damage calculation embedded in tort law for determining compensation is not compatible with the types of damages that are derived from (stated) preference based techniques because such studies are always carried out after the damage has occurred and can not reflect pre-existing values independent of the accident and of the valuation process.

Economists do recognise that statements concerning the willingness to pay to avoid damage is a different welfare concept from the valuation of damages to an environmental resource after the occurrence of harm. This simply means that stated preference techniques should be designed so as to capture the change in the value of the asset as a result of harm as opposed to estimating WTP to avoid damage. This is an important design issue that must be incorporated into courtroom directed valuation.

6.5.4. The debate over standing

Finally, the most critical issues concerning the use of valuation techniques in court concerns the question: "Whose preferences matter?" Though there is a extremely voluminous literature on various issues associated with estimating the (unit) value of environmental damages there has been disproportionately less discussion on the issues of standing, that is the issues involved in determining whose preferences are to be included and whose to be excluded in a natural resource damage assessment.[34,35]

[34] The term standing to refer to the issue of who is to be counted in CBA has been coined by Whittington, and Macrae (1986).

Generally, we can say that we should count whoever has suffered a *real* loss. Determining this population is relevant for both the purposes of sampling and aggregating. Sampling will produce an estimate of unit average damage. Aggregation will produce the total amount of damages. The choice of the relevant affected population will affect the estimated shape of the demand function but, more importantly, the choice of population will have an even greater effect on the estimated level of damages. Hence, if we were merely interested in unit mean values, then the problems of defining the relevant population are not so severe. Yet, in environmental damage assessment aggregate values are what matter and hence determining who should be included in the aggregation population can have profound consequences for the outcome of the litigation process.[36]

The economic conception of standing is much broader than the legal definition. It implies that everyone who experiences a real welfare loss should be included in the aggregation population (Whittington and Macrae 1986). Legal standing is a much less inclusive concept and includes those individuals that can pursue a lawsuit or other cause of action against another party. When property rights are certain determining legal standing is straight forward. Yet, in cases involving natural resource damages property rights over the resources involved are often uncertain and hence standing is far from an unambiguous matter. What must be resolved is not which individuals have experienced a welfare loss but which individuals have experienced a *compensable* welfare loss. Commentators have tried to discern the legal and economic constraints that delineate the appropriate "welfare space" for assessment of natural resource damages.[37] All those individuals in the appropriate welfare space that experience a loss consistent with these economic and legal requirements/constraints are to be included in aggregation. Yet, there is considerable debate on the nature and extent of these constraints. A

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[35] Considering that determining the relevant population determines both the estimated demand function (required to estimate unit damage values) and the subsequent estimated aggregated values such lack of comparative attention is in fact irregular. One explanation for this could be that such issues are of political or normative nature and should not be the subject matter of economics. Of course, economics and CBA is unavoidably laden with value judgements and hence such an assertion bears little weight.

[36] The Eagle Mine case is typical of the relative importance of the standing issue over the issue of estimating average unit damages. In this case the state of Colorado sought damages for the release of hazardous substances into groundwater. What is interesting is that although both the trustees and the defendants estimates of unit average damages coincided their estimates of aggregate damages differed by several orders of magnitude (see Kopp and Smith 1989 for more details).

[37] The term "welfare space" is attributed to Trumbull (1990)

categorisation and clarification of some of these issues follows below. Only a selection of the issues involved is presented.[38] The issue of standing is still very much open both in the courts and in the academic journals.[39] The exposition highlights some of the misunderstandings and disagreements between economists and lawyers rather than purporting to offer a definitive resolution. More importantly, it is shown that the issues are equally relevant for consideration in the proposed EU liability system.

6.5.4.1.Standing and Use values

For the case of use values, determining the population for sampling and aggregation is less contentious. All individuals who can reasonably claim an expectation of possible or potential future use may be included in the population. There are some disagreements between the economic and legal conception of standing over certain categories of individuals such as children, 'rubberneckers' (those who go and observe damaged natural sites and clean-up/restoration operations), and tourists and foreigners (e.g. illegal aliens). Disagreement also exists over how to count individuals that claim damages when the facts (or experts) attest that there is no physical injury to the environmental site (e.g. individuals who continue not to use a damaged recreational site because they are unaware or not convinced that the site has been adequately resorted). Rulings in court cases have varied on whether and in what way preferences of such individuals are to be counted in the aggregation process. For a *theoretical* discussion of these issues and references to contrasting case rulings in the US see Dunford *et al.* (1997) and Randall (1997), Whittington and Macrae (1986), Trumbull (1990), Zerbe (1991, 1998, 2001). For an exposition of how opposing parties and courts deal with such issues of standing for use values in practice see Chapman and Hanemann. (2000) who report on The

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[38] For a more comprehensive view of the debate see Dunford et al (1997), Randall (1997), Johnson et al (2001), Zerbe (1991, 1998, 2001) Trumbull (1990), Whittington and Macrae (1986) Kopp and Smith (1989). The discussion in these papers assume that non-use values are invariant across individuals. The issue they discuss is how to identify who has standing and then impute the same average value to the specified population. The discussion concerns "who counts" in aggregation. Yet, the issue of standing can also be viewed as a matter of degree. That is, individuals may have partial and full standing. Here the issue is "how much weight do we assign to each individual or group of individuals". Such forms of 'non-temporal' or 'spatial' discounting' can be performed using income weights, distance decay assumptions or other variables affecting WTP. For a discussion see Bateman *et al* (2000), Moran 2000, Pearce (2000), Trumbull (1990) Johnson et al 2001, Pate and Loomis (1997) and Sutherland and Walsh (1985).

[39] "Of all the issues of CBA few are misunderstood more", Trumbull (1990, p.201).

American Trader Case, one of the few cases that used individual preference based values that was not settled out of court. [40]

[40] Discussion of other natural resource cases in the US can be found Brown *et al* (1983), Kopp and Smith (1993) and Ward and Duffield (1992).

6.5.4.2.Standing and NUVs

The issues surrounding the issue of standing for estimating unit and aggregate NUVs are much more contentious. Apart from measurement issues, the main problems of standing for non-use damages are two. The first raises concerns over the 'legitimacy' of various motivations (namely altruism and moral commitment) leading to individual NUVs while the second concerns the extent of the welfare space that defines compensable losses in non-use values.[41] Whilst, the criticism on the 'illegitimacy' of motives for NUV can be dismissed on grounds of misconception of modern utility theory, the issues raised as to whose non-use preferences are to be counted are much more serious.[42] In practice the courts in the US have been inconsistent in defining the relevant population of non-users[43] while one of the few legal disputes in the UK that considered non-use values also produced conflicting results.[44]

The recognised rights of the claimant do not constitute a sufficient basis for delineating between those within and without the affected population. This is so because of the nature of NUVs. The later have been defined as the value one obtains from a natural resource when no present or future direct personal use is realised or intended (see Pearce and Turner, 1990). It is best to think of NUVs as not held over natural objects themselves but over the flows (or uses)

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[41] The issues of standing for use values (children, rubberneckers, tourists, foreigners etc.) mentioned above also apply to NUVs and become even more troublesome.

[42] See Beckerman and Pasek (1996) Lockwood (1999), Rekola *et al.*, (2000), Spash (2000) and (1997), Diamond (1996), Schade and Payne (1994), Opaluch and Griglunas (1992), Sagoff (1994), Blamey (1995) and (1998), Milgrom (1993), and Edwards (1992) for arguments on how motivations of altruism and commitment are incompatible with the economic conception non-use values. See Randall (2002), Pearce (2000), Hanemann (1996), Arrow (1951), Becker (1993) for the opposite view. These authors argue that criticisms over the 'legitimacy' of values are often based on an ill conception or 18th century caricature of utility theory. Instead, it is argued that, the contemporary revealed preference foundation of utility theory is quite inclusive and is able to account for choices motivated by a plurality of motives. For modern utility theory it is not essential that ones preferences are to be motivated solely by pure self-interest to qualify for economic relevance. For more specific discussions on how economic theory can cope with non-use values motivated by various types of altruism see McConnell (1997), Johansson (1992), Quiggin (1997). For a discussion of how economic conception of altruism can be used to define the relevant compensable welfare space see Randall (1997) and Zerbe (2001).

[43] In the Nestucca oil spill case, for example, the populations of Washington and British Columbia were used for estimating damages, while in the case of the Exxon Valdez spill the population of the entire United States was held to be the potentially affected population. In a more recent case, *Montrose Chemical Corp. v. Superior Court,* the Trustees defined the potentially affected population as the English-speaking households in California (Zerbe 1998).

these resources generate. Since non-use value by definition excludes personal enjoyment of these uses, it can be inferred that NUVs are derived from the knowledge that certain flows from a natural resource benefit certain other constituents. These constituents could be other people in the current or future generation leading to altruistic and bequest values or nature itself leading to existence and intrinsic values. [45] Hence, human *perception* or some *knowledge* about the resource is an important part of the definition of NUVs and has been the basis for the debate over standing.

Dunford *et al.* (1997) and Johnson *et al.* (2001) have argued that demand for knowledge about the resource and/or its injury are required for one's NUV to have legal standing. The authors acknowledge that since NUV leave a very poor behavioural trail the courts are uncertain as to who has in fact experienced a loss in NUV (and thus who has standing) as the result of an injured natural asset. They argue however that observing the demand for information about the resource and/or its injury can provide a good indication as to who in fact has experienced such a loss and thus who should be compensated. They suggest using marketing questionnaire techniques (similar to those used in stated preference methods) to ascertain the percentage of people in a society (which could extend to the national level) that have some prior knowledge of the resource and some current or potential demand for information about the injury. They argue that it is only these individuals that should be granted legal standing. The rationale of the argument is that people with no prior demand for information about the resource and/or its injury in fact do not have true non-use values. That is, the lack of such demand for information tells the court something about the true preferences of these individuals. NUVs were defined as being a matter of conception and conception, their argument goes, involves some prior knowledge. Information acquisition activities involve opportunity costs and are thus indicators of ones interest in (or intensity of and preferences for) a particular natural resource. Respondents in CV studies that have not (endogenously) acquired such information nevertheless receive (exogenous) information from the study itself. The authors in essence are

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[44]See Moran (2000) for a description of how the issue of standing over NUVs was handled in a case between Thames Water Utilities and the UK Environment Agency over ground water abstraction damages.

[45] The concept of intrinsic value should not be interpreted as meaning the value something has in and of itself irrespective of any human ''valuer'. Such a metaphysical conception of value may have philosophical basis but is of no practical merit. That is, it is entirely irrelevant in a framework that involves making choices. Instead, intrinsic value can be interpreted in an anthropocentric manner, in that a human agent must acknowledge such a

claiming that expressed non-use values from individuals with no prior or no intended demand to acquire information are somehow "induced'', constructed, "hypothetical" or even "fictional" preferences and that the subsequent estimated losses would not have occurred if the respondent had not been sampled. The usefulness of the estimated values from such individuals for damage assessment is questionable. This raises the familiar issues of the role of information in stated preference studies.[46] Though the literature provides ambivalent guidance in resolving these informational issues the crux of their arguments point to an important distinction between economic and legal standing for NUVs. The emphasis on supplying information to respondents makes sense in "traditional" non-use value studies designed to help policy makers evaluate the potential benefits of policy alternatives. These are *ex ante* studies of proposed changes and thus neither the entire number of constituents of a society nor the sample used in a stated preference study can have knowledge of the proposed changes. Further, measures of awareness and knowledge may be poor indicators of voting behaviour, regulatory mandates, or budget-allocation decisions and may have little to contribute to determining economic standing. It does not necessarily follow, however, that supplying information to respondents is also appropriate when assessing *ex post* compensation for actual welfare losses from a sample of respondents representing the general population (Dunford *et al.,* 1997). Hence, attempts by natural resource trustees to measure aggregate losses in NUVs over informationally unrepresentative sub-samples of larger populations may be inconsistent with the *revealed* knowledge and concerns of that population (Johnson *et al.,* 2001). Some sort of prior knowledge of the resource might be made a prerequisite to claiming standing, and thus to taking part in a survey regarding NUVs.

Economists are divided over the necessity of positive (actual or potential) information demand as a precondition for real compensable losses in NUVs (e.g. see Zerbe (2001) and (1998) Randall (1997) arguing against while Moran (2000) arguing in favour of it). In the former camp there are two counter-arguments worth mentioning.

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value. Hence, 'trees do have standing' if people have preference for granting such rights (on this issue see Stone 1974).

[46] For an over of these issues see Munro and Hanley (2000), Chilton and Hutchinson (1999), Blomquist and Whitehead (1998), Cameron and Englin (1997), Boyle, K.J *et al* (1995), Whitehead, and Blomquist (1991), and Bergstrom, Stoll and Randall (1990).

First, it has been argued that individuals have preference over *classes of environmental goods* (not particular types of environmental resource) and thus they would suffer a legitimate loss in NUV from a damage to a particular environmental asset even if they had no prior knowledge of the asset and/or the injury (Randall, 1997; Zerbe, 2001, 1998, and 1991). Randall describes the existence of such preference emerging as a form of heuristic to deal with the realities of an overwhelming complex world and incomplete knowledge: people care about a class of things implies caring about particulars in that class. People that have such a class in their utility function once informed about the injury to a particular member of this class *may* suffer a utility loss. There are several objections to this reasoning. First, the fact that some individuals have resorted to developing such heuristics tells us something about intensity of their preferences. Second, accepting general rather than specific knowledge of environmental resource allows for the aggregation population to be overwhelmingly large. This may be reasonable for some unique natural resources but is not convincing for resources with many substitutes. Third, accepting that individuals care about *classes* of environmental resource poses problems on interpreting how people make choices over *specific* resources when asked to do so. That is, if, for example, people care about 'all species', on what basis can their intensity of preferences (i.e. their values) differ for one particular species to another? Would this mean that individuals would have the *same* value for *any* member of the class of resources? If not, then on what basis would these values differ other than individuals have different orderings for such specific preferences? Alternatively, how would individuals tradeoff any species within that class against the acquisition of a good from another class (such as a road project or a hospital project)? Fourth, these arguments fail to appreciate/distinguish that such types of meta-preferences can allow for one to have economic but not legal standing. The purpose of damage assessment is to obtain compensation for injuries to *specific* natural resources. Thus general knowledge of 'the environment' is not sufficient for *legal* standing. While it may be good public policy to protect the environment (economic standing), there is no basis for crediting unaware citizens with *compensable* welfare losses (Johnson *et al.*, 2001).[47] General knowledge of 'the environment' is more of a political position than a justification for a legally recognised right.

[47] Note that there is also ample empirical evidence that WTP from non-users declines and eventually is reduced to zero when demand for information is absent. Various studies have shown that NUV have declined with distance

Secondly, one may argue that prior knowledge of the resource is not required since society "owns" the resources managed by trustees (Zerbe 1998). Yet this view ignores a crucial difference between NUVs for public resources and private property. NUVs do not exist independent of individual perception. Hence, losses in NUVs require some prior knowledge whereas losses in use values do not. Also, justifying legal standing on property rights is troublesome since property rights are often not clear (e.g. to whom do these rights extend to?).

Zerbe (2001, 1998) provides an argument similar to that found in Randall (1997) but basis it in the context of rights. He argues that individuals care about environmental wealth in general and that once they are informed about the damage to a particular environmental resource they may suffer a real and legitimate loss in non-use value. He provides an example of a rich individual who owns many firms which are run by managers. Though the wealthy individual does not have knowledge of his specific firms he/she would receive a legitimate welfare loss if were to find out that one of his/her enterprises went bankrupt.[48] There are two problems with this example: first the individual has the *private* property right over all his/her firms. The individual receives use value from his/her wealth. Value from privately held resources is not a matter of perception (it arises from personal benefits enjoyed by the individual) while non-use values over commonly owned resource arise from the knowledge that certain environmental flows accrue to others. Hence, prior knowledge is a requirement for non-use values to exists *independently* of a CV study. Further, we can interpret individuals with no demand for knowledge of the resource as having 'waived' their right to the resource and thus as not having standing.

The White Paper makes no explicit reference to standing over non-use values. This is odd granting that much of the theoretical and practical issues on using valuation in the courts that have been discussed in academic journals and in courts in the US have been preoccupied with non-use values. Yet, such issues are bound to emerge in the EU as well. For example the White Paper allows (under certain conditions) for non-governmental agencies to pursue law suits and claim damages on 'behalf of society'. It is likely that a large proportion of such

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and familiarity with the resource. See Bateman *et al.* (2000), Moran (2000), Pate and Loomis (1997), Smith and Desvousges (1986), Peters *et al* (1995) and Sutherland and Walsh (1985).

sought damages would be of the non-use value type and hence the issues discussed in this section will have to be further considered. The questions of 'who has standing?' are likely to preoccupy the courts in the implementation of the Liability Directive.

[48] Presumably the individual in the hypothetical example has inherited his/her wealth since otherwise the individual would have engaged in information acquiring information in order to build his/her fortune.

6.6. Concluding remarks and suggestions for future research

The concluding chapter of this thesis sought to assess the US experience with using valuation in courts with the aim of providing suggestions to the EU, as European legislators formulate the future direction of the EU environmental liability regime. The US experience highlights the issues that are likely to pre-occupy the deliberations in the EU. These were identified as: i) issues of accuracy of valuation studies; ii) the cost of valuation studies iii) the issues of consistency of valuation with the compensatory objective of a liability regime; and v) issues of standing and aggregation regarding non-use values.

In the review of these issues we believe that we have identified certain crucial and outstanding problems in the use of valuation in courts. The first concerns the accuracy of valuation studies for damage assessment. We believe that appropriate survey design is capable of providing credible results, and measures that assess credibility; however, it will always be difficult to provide a reasonably tight margin of error around these results.

Some economists argue that utilising even imprecise information from valuation studies in damage assessment cases can improve the decision making process. It is argued that skewed indicators of individual preferences can still be useful indicators, provided the ways in which they are skewed are understood (e.g. Randall, 2002 and Hubin, 1994). Even prior to its repair, the Hubble telescope was apparently returning valuable information despite the distortions produced by the improper design of the telescope (Hubin, 1994, p.185).[49] Hence, valuation estimates may be suitable for guiding penalty negotiations. Yet, the variance around these results make them difficult to provide precise estimates adequate to form the basis for personal damages.

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[49] This last point can be better clarified by using an analogy drawn by Brookshire and McKee (1994, p. 70-1) between weighing two types of errors (over or under estimation of damages) with the decision encountered in statistics when dealing with Type I and Type II errors. If we reject all information for individual preferences, the best the court can achieve is to assign a uniform distribution to our estimate of the value of the environmental damages. The information from preference based valuation studies allows the to court update this prior distribution by employing Bayes' Rule to obtain a posterior distribution which by definition will have a smaller variance then the original and thus will provide a better measure of central tendency. The larger the variance the larger the chance of committing a Type I error, incorrectly rejecting the null hypothesis concerning the value of the environmental damages.

Concerns over the of accuracy valuation studies are still the subject of ongoing research by academics working in the field. Various new estimation and validation techniques are constantly being examined. The technical results from Chapters 2, 3 and 4 provide contributions in this direction. Other promising areas of research that have been acknowledged as provided avenues for enhancing valuation accuracy and minimising error are methods for fusing/combining valuation data sets (e.g. Adamowicz *et al.* 1994) as well as methods for non-parametric estimation (e.g. Haab and McConnell, 2002).

The second area of concern for the use of valuation in courts has to do with the cost of implementing credible valuation studies. The conduct of a credible study valuing a specific resource will run into the tens of thousands of EUROs, and possibly about one hundred thousand EUROs per study. It is simply not possible to conduct these studies for each damaged resource, and only the very worst imaginable incidents would be assessed at this cost. This will of course reduce significantly the usefulness of an environmental liability system. It is possible to use previous assessments as a guide to damages in other cases, but this merely expands the margin of error that was the basis for concern in the previous paragraph. Thus, the problem of costly assessment implies a large loophole in the system of environmental liability.[50]

This issue highlights the need for research into 'cost saving' techniques.[51] For example, research by Bateman *et al.* (2001a and 2001b) has shown under what circumstance multiple

[50] To address this point law experts have proposed a variety of civil penalties schemes as an alternative to case-by-case judicial determination of natural resources damage liabilities which are argued to be more cost-effective. For example, Stewart (1995) suggests the use of civil penalties for causing resource injury or a system, enforced through administrative or judicial proceedings, of scheduled damages similar to workers compensation. In both cases the amount of penalty would be determined or bound *ex ante* through scaling based on the type and value of resource injured and magnitude of the spill or release in question. These alternatives would involve an up front fixed costs for determining these scales but avoid the administrative transaction costs of assessing *ex post* damages on a case-by-case basis. This prescription has many affinities with the rationale of the benefit-transfer approach. Also, Stewart (1995) proposes the use of jury-based valuation approaches in order to determine these scales that can include compensation for both use and non-use values. He argues that jury approaches capture the collective dimension of environmental values (i.e. values as the outcome of deliberation and dialogue) that individual preference values neglect.

[51] In fact, Carson *et al.*, (2001) identify that the most important area of research is to try to "determine how to reduce the cost of conducting CV studies while still maintaining most of the quality of the very best studies now being conducted". The authors argue that "development and research along these lines will be crucial in effectively incorporating the public's preferences into the environmental decision making arena".

WTP scenarios can be elicited from the same individual without leading certain known biases (such as ordering bias). An application of this approach was presented in Chapter 5. Other areas of future cost saving research include how to effectively use and weight convenient samples (e.g. Harrison and Lesley, 1996) as well as improving mail and internet survey techniques (e.g. Dillman, 2000, Flores, 2002).

Finally, the most significant issue concerning the use of valuation concerns "who to survey?" and "who to count?" in the aggregation process. Any harm to a natural resource will be substantial if a large enough group of individuals is allowed to claim damages regarding it. And, if the nature of the harm we are assessing concerns "non-use", how do we decide which "nonusers" to exclude from the assessment? This is the most serious problem that undermines the usefulness of valuation techniques with respect to goods such as biodiversity. The EU Directive makes clear that environmental groups will be granted standing to claim such damages. Yet, membership of an environmental organisation would seem to be a better basis for involvement at the political rather than the judicial level of government. Courtrooms have usually been reserved for use by those who are individually and directly affected by others' actions, while the legislatures have been reserved for abstract policy debates. Also, the Directive must clarify on account of which group are environmental organisations granted standing: its membership, the local community, all persons who knew of the resource's prior existence, the class of all interested environmentalists? A fruitful area for future research to address the issues of standing and aggregation of harm would be to investigate alternative bid functions that allow for non-temporal discounting. For example, the work by Betamen *et al.*, (2000) on value decay functions provides an econometric approach to determining standing that tries to avoid some of the issues raised above.

These concerns and others have moved the courts in the US toward "in kind" substitution of resources, and away from damage assessment. This has happened in recognition of the costs of individual assessment studies and the residual uncertainty remaining after they are undertaken. When injured resources are replaced by reasonable substitutes, the valuation problems listed above are alleviated. However, there are two problems with this approach that may still necessitate the use of valuation techniques.

First "in kind" substitution depends on the availability of reasonable replacement resources for its existence. This is difficult in any circumstances, and even more difficult in the EU where the only resources for which biodiversity damages may be claimed are the relatively unique ones on the Natura 2000 list. So, traditional valuation techniques such as CV might have to remain a tool of last resort in Europe even if it is possible to move away from it in the US.

Secondly, establishing the level and quality of "in kind" substitution requires some sort of trade-off between environmental resources. This may enhance the role of choice modelling approaches in courts since these methods are better suited in dealing with trade-offs between alternatives and between characteristics of alternatives. Hence, a fruitful area of research would be the design of choice experiment studies for usages in courts.[52] The extensive recommendations in Adamowicz and Boxall (2001) and Hanley and. Mourato (1999) set the directions of this research agenda. For example, the latent segment model presented in Chapter 3 can be used to identify segments that differ according to the relative importance placed on characteristics of a particular choice situation. Boxall and Adamowicz (1999) postulate that such a method may be helpful in environmental damage assessment where it would be useful to know if values differed according to the importance of the use of the damaged area by different groups of citizens. Another promising avenue for exploring trade-offs for "in kind" substitution are novel methods that attempt to combine valuation with participatory approaches (e.g. citizens or valuation juries; see Brown *et al.* 1995). Such 'hybrid' methods aim at combining the strengths from each decision making approach. Two promising examples (still in embryonic stage) are the Market Stall approach by Mcmillan *et al.* (2000) and the Valuation Workshop approach by Kenyon and Hanley (2000).

[52] The work by Breffle *et al.* (1999) provides the only known case where choice modeling has been used to assess damages. The specific application estimated recreational fishing damages. The method has not yet been extended to assessing non-use damages.

BIBLIOGRAPHY

Adamowicz Wiktor, Joffre Swait, Peter Boxall, Jordan Louviere, Michael Williams. (1997). 'Perceptions versus Objective Measures of Environmental Quality in Combined Revealed and Stated Preference Models of Environmental Valuation', *Journal of Environmental Economics and Management*, 32 (1): 65-84.

Adamowicz, W. and P. Boxall (2001). 'Future Directions of Stated Choice Methods for Environment Valuation', *Paper prepared for: Choice Experiments: A New Approach to Environmental Valuation April 10, 2001 London, England*

Adamowicz, W. *et al.* (2000). 'Stated-Preference Methods For Valuing Environmental Amenities', in Bateman, I. and K. Willis (Eds). *Valuing environmental preferences : theory and practice of the contingent valuation method in the US, EU, and developing countries',* New York : Oxford University Press

Adamowicz, W., J. J. Louviere and J. Swait (1998). *Introduction to Attribute Based Stated Choice Methods,* Final Report to Resource Valuation Branch, Damage Assessment Centre, US National Oceanic and Atmospheric Administration, Department of Commerce, prepared by Advanis, Inc. Edmonton, Alberta, Canada.

Adamowicz, W.L., J. Louviere and M. Williams (1994). 'Combining Stated and Revealed Preference Methods for Valuing Environmental Amenities', *Journal of Environmental Economics and Management.* (26): 271-292.

Alberini, A., Kanninen, B., and Carson, R. (1994). 'A general model for double-bounded discrete choice contingent valuation data'. *Paper presented at the AERE Session of the ASSA*

Alexander, Robert R. (2000). 'Modelling species extinction: the case for non-consumptive values', *Ecological Economics,* 35 (2): 259-269

Alibhai, S.K and Jewell, Z.C. (1993). 'Saving the Last Rhino: In Situ Conservation or Captive Breeding?' *Rhinowatch*, 1993

Allenby, G. (1990). 'Hypothesis testing with scanner data: The advantage of Bayesian methods'. *Journal of Marketing Research,* 27:379-389.

Allenby, Greg, Geraldine Fennell, Albert Bemmaor, Vijay Bhargava, Francois Christen, Jackie Dawley, Peter Dickson, Yancy Edwards, Mark Garratt, Jim Ginter, Alan Sawyer, Rick Staelin, Sha Yang (2002). 'Market Segmentation Research: Beyond Within and Across Group Differences' *Marketing Letters,* 13 (3): 233-243

Alpizar, Francisco and Fredrik Carlsson (2001). 'Policy Implications and Analysis of the Determinants of Travel Mode Choice: An Application of Choice Experiments to Metropolitan Costa Rica', *Working Papers in Economics no. 56, September 2001, Department of Economics, Göteborg University*

Alvarez-Farizo, B., Hanley, N., Wright, R.E., and MacMillian, D.C. (1999). 'Estimating the Benefits of Agri Environmental Policy -: Econometric Issues In Open-Ended Contingent Valuation Studies'. *Journal of Environmental Planning and Management*, 42: 23-43.

Amemiya, T (1984). Tobit Models: A Survey, *Journal of Economics,* 24, 3061

Amemiya,T. (1981). 'Qualitative Response Models: A Survey', *Journal of Economic Literature*, 19: 1483-1536

Anderson, Donald A. and James B. Wiley (1992). 'Efficient Choice Set Designs for Estimating Available Cross-Effects Models', *Marketing Letters, 3.4* (October): 357-370.

Andreoni, J. (1990). 'Impure Altruism and Donations to Public Goods: A Theory Of Warm Glow Giving' *Economic Journal*, vol.100: 464-477.

Arrow, K. (1951). *Social Choice and Individual Values,* Wiley, New York.

Arrow, K., R.Solow, E.Leamer, P.Portney, R.Radner and H.Schuman (1993). 'Report of the NOAA Panel on Contingent Valuation', Federal Register, 58, 4601-14.

Arrow, K.J and A.C. Fisher (1974). 'Environmental Preservation Uncertainty and Irreversibility' *Quarterly Journal of Economics*, 88, pp.313-319

Baker, G.A. and Burnham, T.A. (2001). 'Consumer response to genetically modified foods: market segment analysis and implications for producers and policy makers'. *Journal of Agricultural and Resource Economics* 26: 387-403.

Baker, G.A. and P.J. Crosbie (1993). 'Measuring Food Safety Preferences: Identifying Consumer Segments' *Journal of Agricultural and Resource Economics,* 18, 277-287

Balistreri, E., G. McClelland, G. Poe, and W. Schulze (2001).'Can Hypothetical Questions Reveal True Values? A Laboratory Comparison of Dichotomous Choice and Open ended Contingent Values with Auction Values' *forthcoming in Environmental and Resource Economics.*

Balmford, A. (2000). 'Priorities for captive breeding – which animals should board the ark?', in Entwistle, A and Nigel Dunstone (Eds.). *Priorities for the Conservation of Mammalian Diversity: Has the Panda had its Day*, Cambridge, CUP, pp. 291-307

Banzhaf - Ruby, Melissa, F. Reed Johnson and Kristy E. Mathews (2001). 'Opt out Alternatives and Angles Preferences' in Bennett, J and R. Blamey (Eds). The Choice Modelling Approach to Environmental Valuation, Edward Elgar, London, pp. 133-156.

Barbier, E.B., Burgess, J.C., Swanson, T.M., Pearce, D.W., (1990). *Elephants, Economics and Ivory.* Earthscan Publications, London.

Barendse *et al.*, (Eds). (1998). NOW International Conference, Beyond Sustainability *integrating behavioural, economic and environmental research, Conference Report, 19-20th November 1998, Amsterdam, Netherlands.*

Barnes, J.I., (1996). 'Changes in the economic use value of elephant in Botswana: The effect of international trade prohibition'. *Ecological Economics*, 18, 215–230.

Baron, Jonathan and Ilana Ritov (1994)., 'Reference Points and Omission Bias,' *Organizational Behavior & Human Decision Processes,* 59 (September): 475–498.

Bartholomew, D.J. (1987). *Latent variable models and factor analysis*, London: Griffin

Bateman, I. and I. Langford (1997). 'Non users Willingness to pay for a National Park: An application and Critique of the contingent valuation', *Regional Studies*, vol. 31 (6): 571-582

Bateman, I.J, Cole, M , Cooper, P. , Georgiou, S. , Hadley, D. and POE, G.L., (2001a). Visible Choice Sets and Scope Sensitivity: An Experimental and Field Test of Study Design Effects upon Contingent Values, Paper submitted to *The Eleventh Annual Conference of the European Association of Environmental and Resource Economists (EAERE).* University of Southampton, United Kingdom, June 28th - June 30th 2001.

Bateman, I.J. (1999). 'Environmental impact assessment, cost-benefit analysis and the valuation of environmental impacts', in J. Petts, *Handbook of Environmental Impact Assessment, volume 1-* environmental impact assessment process, methods and potential. Oxford: Blackwell Science

Bateman, I.J., Langford, I.H., Jones, A.P. and Kerr, G.N. (2001c). 'Bound and path effects in double and triple bounded dichotomous choice contingent valuation'. *Resource and Energy Economics* 23(3): pp.119-213.

Bateman, Ian J. and Andrew P. Jones (2003). 'Contrasting Conventional with Multi-Level Modelling Approaches to Meta-Analysis: Expectation Consistency in U.K. Woodland Recreation Values', *Land Economics*, 79 (2): 235-258

Bateman, Ian J., Antreas Tsoumas, Stavros Georgiou and Ian H. Langford (2001b). 'Investigating The Characteristics Of Stated Preferences For Reducing Air Pollution Impacts: A Contingent Valuation Study', *CSERGE Working Paper GEC 95-30*

Bateman, Ian Richard T. Carson, Brett Day, Michael Hanemann, Nick Hanley, Tannis Hett, Michael Jones-Lee, Graham Loomes, Susana Mourato, Ece Özdemiroglu, David W. Pearce, Robert Sugden and John Swanson (2002). *Economic Valuation With Stated Preference Techniques: A Manual (In Association With the DTLR and DEFRA).* Edward Elgar

Bateman, Ian. and Willis, K. G. (Eds). (1999). *Valuing environmental preferences: theory and practice of the contingent valuation method in the US, EU, and developing countries,* New York : Oxford University Press.

Batsell, Richard and Jordan Louviere (1991). 'Experimental Analysis of Choice', *Marketing Letters*, 2(3):199-214.

Becker, G. (1993). 'Nobel Lecture: the economic way of looking at behaviour', *Journal of Political Economy,* 101, June, pp.385-409

Beckerman, W. and J. Pasek (1996). 'Plural Values and Environmental Valuation', *CSERGE Working Paper GEC 96-11.*

Ben-Akiva, M. (1992). Incorporation of Psychometric Data in Individual Choice Models. The American Marketing Association Advanced Research Techniques Forum, Lake Tahoe, Nevada.

Ben-Akiva, M. and B. Boccara (1987). Integrated Framework for Travel Behavior Analysis. IATBR Conference, Aix-en-Provence, France.

Ben-Akiva, M. and B. Boccara (1995). 'Discrete Choice Models with Latent Choice Sets'. *International Journal of Research in Marketing,* 12: pp. 9-24.

Ben-Akiva, M. and J. Swait (1986). 'The Akaike likelihood ratio index'. *Transportation Science,* 20: 133-136.

Ben-Akiva, M. and Morikawa, T (1990). 'Estimation of travel demand models from multiple data sources', in Koshi (ed). Transportation and Traffic Theory, Amsterdam, Elsevier

Ben-Akiva, M. and Steven R. Lerman (1985). *Discrete Choice Analysis, Theory and Application to Travel Demand, Cambridge Mass,* MIT Press

Ben-Akiva, M., J. Walker, A.T. Bernardino, D.A. Gopinath, T. Morikawa, and A. Polydoropoulou. (1997). 'Integration of choice and latent variable models'. Paper presented at the 1997 IATBR, University of Texas at Austin.

Ben-Akiva, M., M. Bradley, T. Morikawa, J. Benjamin, T. Novak, H. Oppewal, and V. Rao (1994). 'Combining Revealed and Stated Preferences Data', *Marketing Letters* 5, 4: pp. 335-350.

Bennett, J and R. Blamey (2001). The Choice Modelling Approach to Environmental Valuation, Edward Elgar, London

Bennett, R (1998). Measuring Public Support for Animal Welfare Legislation: a Case Study of Cage Egg Production. *Animal Welfare,* 7, 1998, 1-10.

Bennett, R.M. and Larson, D. (1996). 'Contingent valuation of the Perceived Benefits of Farm Animal Welfare Legislation: An Exploratory Survey', *Journal of Agricultural Economics*, 47 (2): 224-35

Bennett, R.M.(1995). 'The Value of Farm Animal Welfare' *Journal of Agricultural Economics,* 46 (1): pp.46-60

Bennett, R.M.(1997). 'Farm Animal Welfare and Food Policy', *Food Policy*, 22 (4): 281-88

Bera, A.K. *et al.* (1984). Testing for normality assumption in limited dependent variable models, International Economic Review, 25, pp. 562-578

Berdnt, E. *et al.* (1974). 'Estimation and inference in non-linear structural models' *Annals of Economic and Social Measurement*, 3, pp. 653-665

Bergland, O., Navrud, S. and Magnussen, K. (1995). 'Benefit transfer: testing for accuracy and reliability', *Discussion Paper 95- 3,* Agricultural University of Norway, Department of Economics.

Bergstrom, J.C., Stoll, J.R., Randall, A., (1990). 'The impact of information on environmental commodity valuation decisions'. *American Journal of Agricultural Economics*, 72, 614–621.

Berlyne, D.E. (1960). *Conflict, Arousal and Curiosity*, New York: McGraw Hill.

Bernaards, C.A. & Sijtsma, K. (1999). 'Factor analysis of multidimensional polytomous item response data suffering from ignorable item non-response'. *Multivariate Behavioural Research*, 34, 277-313.

Bernaards, C.A. & Sijtsma, K. (2000). 'Influence of imputation and EM methods on factor analysis when item nonresponse in questionnaire data is nonignorable'. *Multivariate Behavioural Research*, 35, 321-364.

Berrens, Brookshire, Ganderton and McKee (1998). Exploring non market values for the social impacts of environmental policy change, *Resource and Energy Economics*, 20, pp. 117-137.

Bettman, James R., Mary Frances Luce, and John W. Payne (1998). 'Constructive Consumer Choice Processes,' *Journal of Consumer Research*, 25(December): 187-217.

Bettman, James, Eric Johnson, and John Payne (1991). Consumer Decision Making. In *Handbook of Consumer Behavior*, Thomas Robertson and H. Kassarjian, Editors, New York:Prentice-Hall, pp. 50-84.

Bhat, C. (1998). 'Accommodating Variations in Responsiveness to Level-of-Service Measures in Travel Mode Choice Modeling', *Transport Research A*, 32: 495-507.

Bhat, C. (2000). 'Incorporating Observed and Unobserved Heterogeneity in Urban Work Travel Mode Choice Modeling', *Transportation Science*, 34: 228-238.

Bhat, Chandra R., Teresa Frusti, Huimin Zhao, Stefan Schönfelder, and Kay W. Axhausen (2002). 'Intershopping Duration: An Analysis Using Multiweek Data', *Working Paper*

Bishop, R.C. (1982). 'Option Value: An Exposition and Extension', *Land Economics*, 58, (1): 1-15

Blackorby, C. and David Donaldson (1992). 'Pigs and Guinea Pigs: A Note on the Ethics of Animal Exploitation', *The Economic Journal*, 102 (415): 1345-1369.

Blamey, R and J Bennett (2001). 'Yea-saying and Validation of a Choice Model of Green Product Choice', in Bennett, J and R. Blamey (Eds). *The Choice Modelling Approach to Environmental Valuation*, Edward Elgar, London, pp. 178-201

Blamey, R.K. *et al.*, (1995). 'Respondents to Contingent Valuation Surveys: Consumers or Citizens?' *Australian Journal of Agricultural Economics*, 39, pp. 263-88.

Blamey, Russell K. (1998). Decisiveness, Attitude Expression and Symbolic Responses in Contingent Valuation Surveys, *Journal of Economic Behavior and Organization*, 34(4): 577-601.

Blaylock, James R. and Blisard, W. Noel (1992). 'U.S. Cigarette Consumption: The Case of Low-Income Women', *American-Journal-of-Agricultural-Economics*; 74(3): 698-705.

Blisard, W.Noel and Blaylock,-James-R.(1993). Distinguishing between Market Participation and Infrequency of Purchase Models of Butter Demand American Journal of Agricultural Economics; 75(2): 314-20.

Blomquist, Glenn C.; Whitehead, John C. (1995). 'Existence Value, Contingent Valuation, and Natural Resources Damages Assessment' *Growth and Change*; 26(4): 573-89.

Blundell, R and C. Meghir (1987). 'Bivariate Alternatives to the Tobit Model', *Journal of Econometrics*, 34, 179-200

Blundell, R. *et al.* (1998). Collective Labour Supply: Heterogeneity and Nonparticipation, *IFS Working Paper Series WP 20/98*

Blundell, R., J. Ham and C. Meghir (1987). 'Unemployment and Female Labour Supply', *The Economic Journal*, 97, 44-64.

Blundell, Richard (2000). 'Collective Labor Supply: Heterogeneity and Nonparaticipation', IFS Working Paper, W98/20

Blundell, Richard (2001).'Evaluating the labour supply responses to 'in-work' benefit reforms for low income workers' in Taxation, Welfare and the Crisis of Unemployment in Europe, (eds. Marco Buti, Paolo Sestito and Hans Wijkander)., Edward Elgar, 157-187.

Blundell, Richard, Martin Browning and Ian Crawford (forthcoming 2003). 'Nonparametric Engel Curves and Revealed Preference' *forthcoming in Econometrica.*

Bockenholt, Ulf, Dietrich Albert, Michael Aschenbrenner, and Franz Schmalhofer (1991). 'The Effect of Attractiveness, Dominance, and Attribute Differences on Information Acquisition in Multi-Attribute Binary Choice,' *Organizational Behavior and Human Decision Processes, 49*, pp. 258-281.

Bockstael, N.E., K.E. McConnell, and I.E. Strand,(1991). 'Recreation', in J.B. Braden and C.D. Kolstad (1991). (Eds.). *Measuring the demand for Environmental Quality*, Elsevier Science B.V. (North Holland), pp. 225-270.

Bohara, Alok, K. *et el.* (2001). 'Addressing Negative Willingness to Pay in Dichotomous Choice Contingent Valuation: A Monte Carlo Simulation', *Environmental and Resource Economics*, 20, 173-195

Boman, M. and Bostedt, G. (1999). Valuing the Wolf in Sweden: Are Benefits Contingent upon the Supply? In: Boman, M., Brännlund, R. & Kriström, B. (Eds.). *Topics in Environmental Economics*. Kluwer Academic Press, Dordrecht.

Bonnieux, F and P. Rainelli (2000). 'Contingent valuation methodology and the EU Institutional Framework', in Valuing the Environment Preferences, Bateman, I.; Willis, K., eds. Oxford University Press

Bonny, Sylvie (2001). 'Factors explaining opposition to GMOs in France and Europe' Presented at 5th ICABR International Conference on Biotechnology, Science and Modern Agriculture: a New Industry at the Dawn of the Century Ravello (Italy). June 15-18, 2001

Boudreaux, Donald J., Roger E. Meiners; Todd J. Zywicki (1999). Talk is cheap: the existence value fallacy, *Environmental Law*, 29 (4): 765-809

Boxall, P.C., W.L. Adamowicz, and T. Tomasi. (1996). 'Nonparametric tests of the traditional travel cost model'. *Canadian Journal of Agricultural Economics* 44:183-193.

Boxall, Peter C. and Wiktor L. Adamowicz. (1999). *Understanding Heterogeneous Preferences in Random Utility Models: The Use of Latent Class Analysis.* Department of Rural Economy, University of Alberta Staff Paper 99-02

Boyle, K. and R. Bishop (1987). 'Valuing Wildlife in Benefit Cost Analysis: A Case Study Involving Endangered Species', *Water Resources Research* 23(5): 943-950.

Boyle, K. J., M. P. Welsh, and R. C. Bishop, (1993). The Role of Question Order and Respondent Experience in Contingent-Valuation Studies, *Journal of Environmental Economics and Management*, 25 S-80-S-99.

Boyle, K.J *et al.,* (1995). 'Validating contingent valuation with surveys of experts', *Agricultural and Resource Economics Review*, 24 (2): 247-253

Boyle, Kevin J., Thomas P. Holmes, Mario F. Teisl and Brian Roe (2001). Comparison of Conjoint Analysis Response Formats, *American Journal of Agricultural Economics*; 83(2): 441-54.

Bozdogan, Hamparsum (1987). 'Model Selection and Akaike's Information Criterion (AIC). : The General Theory and Its Analytical Extensions,' *Psychometrika*, 52, 345–370

Bradley, M.A. and Daly, A.J. (1994). 'Use of the logit scaling approach to test rank-order and fatigue affects in stated preference data' *Transportation*, 21 (2): 167-84

Breedlove, J. (1999). *Natural Resources: Assessing Non market Values Through Contingent Valuation*, Congressional Research Service, Report for Congress.

Breffle, W.S., E.R. Morey, R.D. Rowe, D.M. Waldman and S.M. Wytinck. (1999). Recreational Fishing Damages from fish Consumption Advisories in the Waters of Green Bay. http://www.fws.gov/r3pao/nrda/recfish.pdf

Breffle, William S. and Edward R. Morey (2000). 'Investigating Preference Heterogeneity in a Repeated Discrete-Choice Recreation Demand Model of Atlantic Salmon Fishing' *Marine Resource Economics*, 15, 1-20.

Bromley, D. and J. Paavola (Eds.)., *Economics, Ethics, and the Environment*, Oxford, Blackwell Publishing

Brookshire, D and M. McKee (1994). 'Is the Glass half empty, is the Glass half Full? Compensable Damages and the Contingent valuation', Natural Resource Journal, 34, 51-72.

Brookshire, D. S. *et al* (1986). 'Existence values and Normative Economics', *Water Resource Research*, 22, 1509-1518.

Brookshire, David S. (1998). 'Effects of Total Cost and Group-Size Information on Willingness to Pay Responses: Open Ended vs. Dichotomous Choice', *Journal of Environmental Economics and Management*, 35 (2): 142-163

Brouwer, R. and F. A. Spaninks. (1999). 'The Validity of Environmental Benefit Transfer: Further Empirical Testing,' *Environmental and Resource Economics,* 14: 95-117.

Brown, G. and J.H. Goldstein (1984). 'A Model for Valuing Endangered Species', *Journal of Environmental Economics and Management,* 11, 303-309.

Brown, G. and Layton, D. F., (2001). A Market Solution for Preserving Biodiversity: The Black Rhino. *In 'Protecting Endangered Species in the United States: Biological Needs, Political Realities, Economic Choices*' (J. Shogren and T. Tschirhart, ed)., Cambridge: Cambridge University Press.

Brown, Gardner M. and., Jason F. Shogren (1998). Economics of the Endangered Species Act, *The Journal of Economic Perspectives*, 12 (3): 3-20.

Brown, Gardner M., Jr., Richard Congar and Elizabeth A. Wilman (1983)._'Recreation: Tourists and Residents,' Chapter 4 in U.S. National Ocean Service, *Assessing the*

Social Costs of Oil Spills:The Amoco Cadiz Case Study, National Oceanic and Atmospheric Administration Report NTIS PB84-100536, Washington, D.C.

Brown, Kelly M. and Laura O. Taylor (2000). 'As You Say, Say As You Do: Evidence on Gender Differences in Actual and Stated Contributions to Public Goods', *Journal of Economic Behaviour and Organization*, 43:127-139.

Brown, T., Champ, P., Bishop, R. & McCollum, D. (1996). 'Response formats and public good donations', *Land Economics*, 72(2): 152-166.

Brown, Thomas C., Peterson, George L. and Tonn, Bruce E. (1995). 'The values jury to aid natural resource decisions.(Speculations).' *Land Economics*, 71(2): 250-60.

Brownstone, D, D, Bunch and K. Train. (1998). 'Joint mixed logit models of stated and revealed preferences for alternative-fuelled vehicles', 8th IATBR conference, Austin Texas, September 1997

Brownstone, D., and K. Train. (1999). Forecasting New Product Penetration with Flexible Substitution Patterns. *Journal of Econometrics* 89(1): 109-29.

Bryan, Stirling et al (1998). Magnetic Resonance Imaging for the Investigation of Knee Injuries: An Investigation of Preferences *Health Economics*, 7 (7): 595-603.

Bullock, David S *et al.* (2000). The Economics of Non - GMO Segregation and Identity Preservation, *INRA working paper*

Bulte, E.H., van Kooten, G.C.(1999). Economics of anti-poaching enforcement and the ivory trade ban. Am. J. Agric. Econ. 81, 453–466.

Burbidge, John B. and Lonnie Magee, A. Leslie Robb (1988). 'Alternative Transformations to Handle Extreme Values of the Dependent Variable' *Journal of the American Statistical Association*, 83 (401): 123-127.

Burton, Michael, Dorsett, Richard and Young, Trevor (1996). 'Changing Preferences for Meat: Evidence from UK Household Data, 1973-93' *European Review of Agricultural Economics*, 23(3): 357-70.

Busemeyer, Jerome E. and Amnon Rapoport (1988)., 'Psychological Models of Deferred Decision Making,' *Journal of Mathematical Psychology,* 32, 1-44.

Buzby, J. C., J. R. Skees and R.C. Ready. 1995. «Using Contingent Valuation to Value Food Safety: A Case Study of Grapefruit and Pesticide Residues.» *Valuing Food Safety and Nutrition* (Ed. by Caswell J. A.). Westview Press, Boulder, Colorado.

Calia and Strazzera (2000). *A Sample Selection Model for protest votes in contingent valuation analysis, EAERE Conference, Crete 2000*

Callicot, J.B. (1986). Intrinsic Value of Non-human Species. *in B.G. Norton (ed.). The Preservation of Species,* Princeton: Princeton University Press.

Cameron, T. and J. Englin (1997). Respondent Experience and Contingent Valuation of Environmental Goods, *Journal of Environmental Economics and Management*, 33(3): 296-313.

Cameron, T.A. and D.D. Huppert (1988). 'OLS versus ML estimation of Non-market resource values with payment Card Interval Data', *Journal of Environmental Economics and Management*, 17: 230-246.

Cameron, T.A. and M.D. James (1987). Efficient Estimation Methods for 'Closed-Ended' Contingent valuation surveys, *The Review of Economics and Statistics,* 69 (2): 270-271

Cameron, Trudy Ann, G. Poe, Robert G. Ethier and William D. Schulze (2002). 'Alternative Nonmarket Value-Elicitation Methods: Are the Underlying Preferences the Same?', forthcoming, *Journal of Environmental Economics and Management*

Carson *et al.,* (1994). Contingent valuation and Lost Passive Use: Damages from the Exxon Valdez, *RFF Discussion Paper 94-18.*

Carson R. (2002). *Contingent Valuation: A Comprehensive Bibliography and History,* Northampton, MA: Edward Elgar.

Carson, R. , T. Groves, and M.J. Machina (1999). 'Incentive and Informational Properties of Preference Questions', *Plenary Address at the annual conference of the European Association of Resource and Environmental Economists, Oslo, Norway, June 1999*

Carson, R. *et al.,* (1995). A Bibliography of contingent valuation studies and Papers, NRDA, Inc, La Jolla.

Carson, R.T, Flores, N.E., and Mitchell, R.C. (2000). 'Theory and Measurement of Passive-Use Value,' in *Valuing the Environment Preferences*, Bateman, I.; Willis, K., eds. Oxford University Press

Carson, R.T. and R.C. Mitchell (1995). 'Sequencing and Nesting in Contingent Valuation Surveys.' *Journal of Environmental Economics and Management* 28(2): 155-173.

Carson, R.T. *et al.* (1994). 'Experimental analysis of choice', *Marketing Letters*, 5, 351-368

Carson, Richard T. (2000). 'Contingent valuation: a user's guide', Department of Economics, University of California, San Diego

Carson, Richard T., Nicholas E. Flores, and Norman F. Meade (2001). 'Contingent valuation: controversies and evidence', *Journal of Environmental and Resource Economics*, 19, 173-210.

Cason, Timothy N and Lata Gangadharan (2000). Environmental Labeling and Incomplete Consumer Information in Laboratory Markets, .Journal of Environmental Economics and Management 43, pp. 113-134

Caswell,-Julie-A. (1998). How Labeling of Safety and Process Attributes Affects Markets for Food, Agricultural-and-Resource-Economics-Review;27(2): 151-58.

Champ, Patricia A., Richard C. Bishop, Thomas C. Brown, Daniel W. McCollum (1997). ' Using Donation Mechanisms to Value Nonuse Benefits from Public Goods', *Journal of Environmental Economics and Management*, Vol. 33, No. 2, pp. 151-162

Chapman David J. and W. Michael Hanemann. (2000). 'Environmental Damages in Court: The American Trader Case. U.C. Berkeley' *Department of Agricultural and Resource Econ., Working Paper No. 913.*

Chapman, Stuart (2001). WWF-UK Communication to the BBC World Report, Friday, 16, February, 2001.

Chern, Wen S. Edna T. Loehman, Steven T. Yen (1995). 'Information, Health Risk Beliefs, and the Demand for Fats and Oils', *The Review of Economics and Statistics*, 77(3): 555-564.

Chesher, A (1984). Testing for Neglected Heterogeneity, *Econometrica*, 52, 865-872.

Child, Dennis (1990). *The Essentials of Factor Analysis,* Cassell Educational Limited

Chilton, S. M. and Hutchinson, W. G. (2000). 'A Note on the Warm Glow of Giving and Scope Sensitivity in Contingent Valuation Studies', *Journal of Economic-Psychology*, 21(4): 343-49.

Chilton, Susan M and Hutchinson, W. George (1999). 'Exploring Divergence between Respondent and Researcher Definitions of the Good in Contingent Valuation, Studies', *Journal of Agricultural Economics*, 50(1), January 1999, pages 1-16.

Cicia, Gianni, Teresa del Giudice and R Scarpa (2001). 'Consumers' perception of quality in organic food: a random utility model under preference heterogeneity and choice correlation from rank-orderings'. *EAAE Seminar on Organic Food Marketing Trends, Chania, Crete, Greece, 7-10 June, 2001.*

Clinch, J. Petera and Murphy, Anthony (2001). Modelling Winners and Losers in Contingent Valuation of Public Goods: Appropriate Welfare Measures and Econometric Analysis, *Economic Journal*, 111(470): 420-43

Consumers' Union Report (2000). 'Summary of Public Opinion Surveys Related to Labelling of Genetically Engineered Foods', www.consumersunion.org/food/summpollny699.htm

Conway, W.G. (2000). 'An overview of Captive propagation' in M.F.Soule and B.A. Wilcox (eds). *Conservation Biology: an Evolutionary Perspective.*

Cooper, Joseph C. and Keim, Russ W. (1996). Incentive Payments to Encourage Farmer Adoption of Water Quality Protection Practices, *American Journal of Agricultural Economics*; 78(1): 54-64.

Cowen, T. (2001). 'Animals and Welfare Economics', *Department of Economics, George Mason University Seminar Paper*

Cragg (1971). 'Some Statistical Models for Limited Dependent Variables with Application to the Durable Goods', *Econometrica*, 39(3): 829-844.

Cropper, M.L. (1988). 'A Note on the Extinction of Renewable Resources', *Journal of Environmental Economics and Management,* 15, pp.64-70

Cubitt, Robin and Robert Sugden (2001). 'On money pumps' *Games and Economic Behavior*, Vol. 37, pp. 121-160.

Cummings R.G and G.W. Harrison (1994). 'Was the Ohio court well informed in their assessment of the accuracy of the contingent valuation method?', *Natural Resource Journal*, 34, pp. 1-36.

Cummings, R, G. (1991). 'Legal and Administrative Uses of Economic Paradigms: A Critique', *Natural Resource Journal*, 31.

Cummings, R.G and G.W. Harrison (1994). 'Was the Ohio court well informed in their assessment of the accuracy of the contingent valuation method?', *Natural Resource Journal*, 34, pp. 1-36

Cummings, R.G and G.W. Harrison (1995). 'The Measurement and Decomposition of Non-use values: A critical Review', *Environmental and Resource Economics*, 5, pp.225-247.

Curtis, J (2000). Modelling the Uncertainty in Distinguishing between Respondent Types in Contingent Valuation Surveys, Crete EAERE conference 2000.

Dalmau-Matarrodona, Eulòlia (2001). 'Alternative approaches to obtain optimal bid values in contingent valuation studies and to model protest zeros. Estimating the determinants of individuals' willingness to pay for home care services in day case surgery', *Health Economics*, 10(2): 101-18.

Damania, Richard and Erwin H. Bulte (2001). 'The Economics of Captive Breeding and Endangered Species Conservation', *Paper Presented at CSERGE Seminar Series, Fall 2001.*

Daum, J.F. (1993). 'Some Legal and Regulatory Aspects of Contingent Valuation' in Hausman, J.A. ed. Contingent Valuation: A Critical Assessment, Elservier Science Publishers.

Davidson, R. and J.G. MacKinnon (1984). ' Model Specification Tests Based on Artificial Linear Regressions', *International Economic Review*, 25, 485-502.

Day, B and Mourato. S. (1998). WTP for water quality improvements in Chinese Rivers, RUWEP, China.

Deaton and Irish (1984). 'Statistical Models for Zero Expenditures in Household Budgets' *Journal of Public Economics*, 23, pp. 59-80

Desvousges W.H. *et al.* (1993). Measuring Natural Resource Damages with contingent Valuation: Tests of Validity and Reliability, in Hausman, J.A. ed. Contingent Valuation: A Critical Assessment (1993).

Dhar, R (1997). 'Consumer Preference for a No-Choice Option', *Journal of Consumer Research*, 24, pp.215-231

Dhar, R and I. Simonson (2001). The Effect of Forced Choice on Choice, Yale University Working Paper

Dhar, Ravi and Rashi Glazer (1996). 'Similarity in Context: Cognitive Representation and Violation of Preference and Perceptual Invariance in Consumer Choice,' *Organizational Behavior & Human Decision Processes*, Vol 67(3): 280-293

Diamond P.A. and J.A Hausman (1994). Contingent valuation: is some number better than no number? *Journal of Economic Perspectives,* 8, (4): pp. 45-64.

Diamond, Peter (1996). Testing the internal Consistency of Contingent valuation surveys, Journal of Environmental Economics and Management, 30, 337-347.

Dillman, Don A. (2000). *Mail and Internet Surveys: The Tailored Design Method*, John Wiley, New York.

Dillon, W and Kumar, A (1993). 'Latent structure and other mixture models in marketing: an integrated survey and overview', in Bagozzi, R (ed), *Handbook of Marketing Research*, London: Blackwell Publishers

Dillon, W and N, Mulani (1989). 'LADI: a latent discrimination model for analysing marketing research data Journal of Marketing Research, 26, 15-29'

Dixon, J.A. *et al.* (1988). *Economic Analysis of the Environmental Impacts of Development Projects,* Earthscan, London.

Donaldson C, Thomas R, Torgerson DJ. (1997). Validity of open-ended and payment scale approaches to eliciting willingness to pay'. *Applied Economics,* 29:79-84.

Donaldson, C et al (1998). 'Limited Dependent Variables in Willingness to Pay Studies: Applications in Health Care, *Applied Economics*, 30, pp. 667-677.

Dubin, J.A. and D.L. McFadden (1984). An Econometric Analysis of Residential Electric Appliance Holdings and Consumption, *Econometrica*, 52(2): pages 345-62.

Dunford, Richard W., F. R. Johnson, R. A Sandefur and E. S. West (1997). 'Whose Losses Count In Natural Resources Damages?' *Contemporary Economic Policy.* 15 (4): 77-87.

Dunlap, R. E. *et al.* (1992). 'Measuring Endorsement of the New Ecological Paradigm- A Revised NEP scale', Working paper.

Dziegielewska, Dominika (2002). 'Does 'No' Mean 'No'? Protest Responses And Contingent Valuation', 2002 World Congress of Environmental and Resource Economists, Monterey, California, June 24 – 27, 2002

Edwards, S.F and G.D. Anderson (1987). 'Overlooked Bias in Contingent valuation surveys: some consideration', *Land Economics*, 63, 168-178.

Edwards, S.F. (1986). 'Ethical Preferences and the Assessment of Existence Values: Does the Neoclassical Model Fit?' *Northeastern Journal of Agricultural Economics*, 15, pp.145-159.

Edwards, S.F. (1992). 'Rethinking Existence Values', Land Economics, 68, 120-122.

Elnagheeb A.H., W. Florkowski, C-L Huang, and C. Halbrendt. 1992. «Willingness to Pay for pST-treated Pork.» *Agricultural Economics*, 8: 45-56.

Elrod, T. J.J. Louviere and K.S. Davy (1992). 'An Empirical; Comparison of Ratings based and choice based models', *Journal of Marketing Research*, 30, 368-377

ENCO (2000). *Assessment of EVRI and the Expansion of fits Coverage to the EU*, ENCO Environmental Consultants a.s.

English, Donald B. K. (1997). 'Effects of Sample Selection on Estimates of Economic Impacts of Outdoor Recreation', *Review of Regional Studies*; 27(3): 219-36.

Eom, Y. S. (1994). «Pesticide Residue Risk and Food Safety Valuation.» *American Journal of Agricultural Economics* 76: 760-771.

ESRC (1999). 'The Politics of GM Foods: Risk, science and public trust', *ESRC, Global Environmental Change Programme*

EuroBarometer (2000). *The Europeans and Biotechnology*, EuroBarometer 52.1, Reported by INRA (Europe). –ECOSA

EuroBarometer (2000). *The Europeans and Biotechnology*, EuroBarometer 52.1, Reported by INRA (Europe). –ECOSA

European Commission (2000). 'Economic Impacts of Genetically Modified Crops on the Agri-Food Sector – A first Review', Working Document, Director General for Agriculture, Commission of the European Communities.

Famulari, M. (1995). A household-based, nonparametric test of demand theory. *Review of Economics and Statistics* :372-382.

Farrow, S (1995). Extinction and Market Forces; Two case studies, *Ecological Economics*, 13, pp.115-23

Fennell, D.A. (1999). Ecotourism: An Introduction, Routledge, NY.

Ferraro, P. J., D. Rondeau, and G. L. Poe, (2002). 'Detecting Other-Regarding Behavior With Virtual Players*', Journal of Economic Behavior and Organization*, forthcoming

Fischhoff, B., M.J. Quandrel, M. Kamlet, G. Lowenstein, R. Dawes, P. Fishbeck, S. Klepper, J. Leland, and P. Stroh. (1993). 'Embedding Effects: Stimulus Representation and Response Modes.' *Journal of Risk and Uncertainty* 6, pp. 211-234.

Fisher, Ann and Robert Raucher (1984). 'Intrinsic Benefits of Improved Water Quality: Conceptual and Empirical Perspectives' in V. Kerry Smith and Ann Dryden Witte (Eds.). *Advances in Applied Microeconomics*. Greenwich, Conn. JAI Press.

Flores, N. (2002). '*Conservation Reconsidered, The Economics of Natural Environments*, and Our Understanding of Environmental Preferences', World Congress, 2002

Flores, N. and R. Carson (1997). 'The Relationship between the Income Elasticities of Demand and Willingness to Pay', *Journal of Environmental Economics and Management*, 33, pp. 287-295.

Forman, A. (1992). 'Linear Logistic latent class analysis for polytomous data' *Journal of the American Statistical Association*, 87, 476-487

Franks, Jeremy R. (1999). 'The Status and Prospects for Genetically Modified Crops in Europe', *Food Policy*, 24 (5): 565-84.

Fredman, P. (1995). The Existence of existence value: a study of the economic benefits of an endangered species. *Journal of Forest Economics* 1(3): 307-327.

Fredman, Peter and Lars Emmelin (2001). Wilderness Purism, Willingness to Pay and Management Preferences: A Study of Swedish Mountain Tourists, *Tourism Economics*, 7 (1): pp. 5-20

Freeman, M.A. (1979). *The Benefits of Environmental Improvement,* Washington, D.C. Resources for the Future.

Freeman, M.A. (1993a). 'Non-use values in Natural Resource Damage Assessment' in Kopp and Smith (Eds). (1993). *Valuing natural assets : the economics of natural resource damage assessment*, Washington, D.C : Resources for the Future.

Freeman, M.A. (1993b). *The Measurement of Environmental and Resource Values: Theory and Methods*, Washington, D.C. Resources for the Future.- Chapter 5

Gao, X. M., Wailes, Eric J. and Cramer, Gail L. (1995). Double-Hurdle Model with Bivariate Normal Errors: An Application to U.S. Rice Demand, Journal of Agricultural and Applied Economics; 27(2): December 1995, pages 363-76.

Garcia, J. and Jose, M. Labeaga (1996). 'Alternative approach to modelling zero expenditure: An application to Spanish Demand for Tobacco', *Oxford Bulletin of Economics and Statistics*, 53 (3): pp.489-506.

Genius, Margarita and Elisabetta Strazzera (2001). 'Model Selection and Tests for NonNested Contingent Valuation Models: An Assessment of Methods. Working paper, Economic Theory and Applications

Goeree, J.K., C. A. Holt, and S. K. Laury (1999). 'Private Costs and Public Benefits: Unraveling the Effects of Altruism and Noisy Behavior', Unpublished Manuscript, Dept. of Economics, University of Virginia, Charlottesville.

Goodwin, H. (1996). 'In pursuit of ecotourism', *Biodiversity and Conservation*, 5(3): 277-291

Gopinath, D., and M. Ben-Akiva (1995). 'Estimation of random distributed value of time', Working Paper, Department of Civil Engineering, MIT.

Gould, W and W. Sribney (1999). Maximum Likelihood Estimation in STATA, STATA Press

Green (1997). *Econometric Analysis,* 3rd Edition, Prentice Hall.

Green, D., K.E. Jacowitz, D. M Kahneman and D. McFadden (1998). 'Referendum contingent valuation, anchoring, and willingness to pay for public goods', *Resource and Energy Economics*, 20, pp.85-116.

Green, W. (1998). *LIMDEP User's Manual*, Econometric software inc.

Grobe, D. R. Douthitt, and L. Zepeda. 1996. «Consumer Risk Perception Profiles for the Food-Related Biotechnology, Recombinant Bovine Growth Hormone(rbGH).» *Strategy and Policy in the Food System: Emerging Issues* (Ed. Caswell J. and R.W. Cotterill). Proceedings of NE-165 Conference, June 20-21, 1996, Washington, D.C.

Gross, John (1995). Heterogeneity in Preferences for local public goods: The case of private expenditure on public education, Journal of Public Economics, 57, pp. 103-127

Gupta, S. and P.K. Chintagunta. (1994). On using demographic variables to determine segment membership in logit mixture models. *Journal of Marketing Research* 31:128-136.

Gurmu, Shiferaw, (1997). 'Semi-parametric Estimation of Hurdle Regression Models with an Application to Medicaid Utilization', *Journal of Applied Econometrics,* 14(4): 469-477.

Haab, T.C. and K.E. McConnell (2002). *Valuing Environmental and Natural Resources: the Econometrics of Non-Market Valuation*, Edward Elgar, Cheltenham, UK

Haaijen, M. (1999). *Modelling Conjoin Experiment Using the Multinomial Probit Model*, Department of Marketing, University of Groningen.

Haaijer Rinus, Wagner Kamakura, and Michel Wedel (2001). 'The 'no-choice' Alternative in Conjoint Choice Experiments,' *International Journal of Market Research*, 43 (1): 93-106.

Haener, Michel. K. and W.L Adamowicz (1998). 'Analysis of 'Don't Know' Responses to referendum Contingent Valuation Questions' *Agricultural and Resource Economics Review*, 27 (2): 218-30

Hallman, William K. (2000). 'Consumer Concerns About Biotechnology: International Perspectives', *Working Paper, Food Policy Institute*

Halstead, J.M. *et al.* (1991). Use of the Tobit Model in Contingent valuation : experimental evidence from the Pemigewasset Wilderness Area, *Journal of Environmental Management*, 33:79-89

Hamstra, I.A. (1998). 'Public Opinion about Biotechnology: a Survey of Surveys', *European Federation of Biotechnology, Task Group on Public Perceptions of Biotechnology*

Hancocks, D (1995). 'An Introduction to Reintroduction' in Norton,Bryan G., Michael Hutchins, Elizabeth F. Stevens, and David Ehrenfeld (Eds.). (1994). *Ethics on the Ark: Zoos, Animal Welfare and Wildlife Conservation*, Washington : Smithsonian Institution Press (pp.181-186).

Hanemann and Kanninen (2000). 'The statistical analysis of Discrete-Response CV data' in Valuing Environmental Preferences: Theory and Practice of the CV methods in the US, EC and Developing countries, Bateman and Willis (eds.), OUP.

Hanemann, M and B. Kriström (1995). 'Preference Uncertainty Optimal Designs and Spikes', in *Current Issues in Environmental Economic*, Johansson *et al.* (Eds.), 58-77, MUP

Hanemann, M. (1994). Valuing Environment through contingent valuation, Journal of Economic Perspectives, 8, (4): 19-43

Hanemann, W. M (1992). 'Natural Resource Damages for Oil Spills in California', pp. 555-80, in J. Ward and J. Duffield (eds.), *Natural Resource Damages: Law and Economics*, John Wiley, New York.

Hanemann, W. M. (1996). 'Theory versus data in the contingent valuation debate', in Bjornstad and Kahn (1996): 38-60

Hanemann, W. M., (1993). *Three Approaches to Defining 'Existence' or 'Non-use' Value under Certainty*. California Agricultural Experiment Station, Giannini Foundation of Agricultural Economics, Working Paper No. 691.

Hanemann, W. Michael and Andrew G. Keeler (1995). Economic Analysis in Policy Evaluation, Damage, Assessment and Compensation: A Comparison of Approaches, *University of Berkeley Working Paper No. 766.*

Hanemann, W. Michael and Kanninen, Barbara (2000). 'The Statistical Analysis of Discrete-Response CV Data' in Bateman, Ian. and Willis, K. G. (Eds). (2000). Valuing environmental preferences : theory and practice of the contingent valuation method in the US, EU, and developing countries New York : Oxford University Press.

Hanley, N and J. Milne (1996). 'Ethical Beliefs and Behaviour in contingent valuation Surveys', *Journal of Environmental Planning and Management*, 39(2): 255-72.

Hanley, N and S. Mourato (1999). 'Choice modelling approaches: superior alternative for environmental valuation?' *EAERE Conference, Oslo, 1999*

Hanley, N, R Wright and G Koop (2000). 'Modelling recreation demand using choice experiments: rock climbing in Scotland' *Discussion paper 2000-11, Economics Department, University of Glasgow.*

Hanley, N. (1998). 'Using Choice Experiments to Value the Environmental', *Environmental and Resource Economics*, 11, (3-4): 413-428

Hanley, N. and Craig, C. (1991). 'Wilderness development decisions and the Krutilla-Fisher model: the case of Scotland's Flow Country', *Ecological Economics*, 4, pp. 145-164.

Harman, H.H. (1976). *Modern Factor Analysis,* 3rd Ed. Chicago: University of Chicago Press

Harris, K.M. and M.P. Keane (1998). A Model of Health Plan Choice: Inferring Preferences and Perceptions from a Combination of Revealed Preference and Attitudinal Data. Forthcoming in *Journal of Econometrics*.

Harrison, Glenn W. (2002). 'Contingent Valuation Meets the Experts: A Critique of the NOAA Panel Report' World Congress 2002

Harrison, Glenn W. and James Lesley (1996). 'Must Contingent valuation surveys cost so much?', *Journal of Environmental Economics and Management*, 31, 79-95.

Haung, Chung L. (1996). Consumer Preferences and Attitudes towards Organically Grown Produce, *European Review of Agricultural Economics*, 23 (3): pp.331-42

Hausman and McFadden (1984). 'A specification test for the multinomial logit model' *Econometrica*, 52, pp. 1219-1240

Hausman, J.A., (Ed.). (1993). *Contingent Valuation: A Critical Assessment*, North-Holland, Amsterdam.

Heckman, J. (1979). Sample Selection Bias as a specification Error, Econometrica, vol 47, no 1, pp.153-161

Heiman, Amir, David R. Just, and David Zilberman. (2000). 'The Role of Socioeconomic Factors and Lifestyle Variables in Attitude and the Demand for Genetically Modified Foods.' *Journal of Agribusiness*. 18, pp. 249 260

Henson, S (1996). 'Consumer WTP for reduction in the risk of food poisoning in the UK', *Journal of Agricultural Economics*, 47 (3): 403-420

Henson, S and B. Traill (2000). Measuring Perceived Performance of the Food System and Consumer Food-Related Welfare, Journal of Agricultural Economics, v. 51 (3): 388 - 404.

Herriges, J.A., and C.L Kling. (1997). 'Nonlinear Income Effects in Random Utility Models'. *Discussion paper, Department of Economics, Iowa State University.*

Heywood, V and S. Stuart (1992). Species Extinction in Tropical Forests, T. Whitmore and J. Sayer (eds). 1992). Tropical Deforestation and Separability Extinction, Chapman & Hall, London, pp.19-117

Hirsch, Werner Z. (1979). *Law and Economics: An Introductory Analysis*, London, Academic Press.

Hoehn, J.P. (1991). 'Valuing the Multi-Dimensional Impacts of Environmental Policy: Theory and Methods' *American Journal of Agricultural Economies*, 73, pp. 289-299

Holzman, Ute (1998). 'Environmental liability in Europe in Christian Hey and Karola Taschner (eds). *EEB Industry Handbook, A critical evaluation of available European Legislation on Industry and the Environment.*

Horowitz J. (1983). 'Statistical comparison of non-nested probabilistic choice model' *Transportation Science,* 17

Hossain, Ferdaus, Benjamin Onyango, Adesoji Adelaja, Brian Schilling, and William Hallman (2002a). 'Uncovering Factors Influencing Public Perceptions of Food Biotechnology' *Working Paper, Food Policy Institute*

Hossain, Ferdaus, Benjamin Onyango, Adesoji Adelaja, Brian Schilling, William Hallman (2002b). 'Consumer Acceptance of Food Biotechnology: Willingness to Buy Genetically Modified Food Products' *Working Paper, Food Policy Institute*

Hossain, Ferdaus, Benjamin Onyango, Adesoji Adelaja, Brian Schilling and William Hallman (2002c). 'Public Perceptions of Biotechnology and Acceptance of Genetically Modified Food', Working Paper, Food Policy Institute

Houtven, van G.L and M.L. Cropper (1993). When is life too Costly to Save?' Evidence from Environmental Regulations', *Resources for the Future Discussion Paper, CRM 93-02*

Howe, C. W. (1993). 'The US Environmental Policy Experience: A critique with Suggestions for the European Community', *Environmental and Resource Economics*, 3, 359-379.

Howe, C.W. *et al.* (1994). Design and Analysis of Contingent Valuation Surveys Using the Nested Tobit Model *Review of Economics and Statistics*, 76(2): 385-89.

Huang, Chung L. and Kan, Kamhon, Fu, Tsu Tan (1999). 'Consumer Willingness-to-Pay for Food Safety in Taiwan: A Binary-Ordinal Probit Model of Analysis' *Journal of Consumer Affairs*, 33(1): 76-91.

Huber, J and J. Pinnell (1994a). 'The impact of set quality and choice difficulty on the decision to defer purchase' Working paper, Duke University: The Fuqua School of Business.

Huber, Joel and Jon Pinnell (1994b). 'The Meaning of a 'NONE' Response in Commercial Studies Using Choice-Based Conjoint.' Presented at Association for Consumer Research Conference, Boston, MA.

Hubin, D.C. (1994). The Moral Justification of Benefit/Cost Analysis, *Economics and Philosophy*, 10, 169-194.

Huhtala, Anni (2000). 'Binary Choice Valuation Studies with Heterogeneous Preferences Regarding the Program Being Valued', *Environmental and Resource Economics*, 16(3): 263-79.

ICABR (2000). 4th International Conference on Biotechnology, Science and Modern Agriculture, a New Industry at the Dawn of the Century, organized by International Consortium on Agricultural Biotechnology Research (ICABR), Ravelo, Italy

ICABR (2001). 5th International Conference on Biotechnology, Science and Modern Agriculture, a New Industry at the Dawn of the Century, organized by International Consortium on Agricultural Biotechnology Research (ICABR)., Ravelo, Italy

ICABR (2002). 6th International Conference on Biotechnology, Science and Modern Agriculture, a New Industry at the Dawn of the Century, organized by International Consortium on Agricultural Biotechnology Research (ICABR), Ravelo, Italy

International Institute for Environment and Development and World Resources Institute (1989). World Resources 1988-89, Basic Books: New York.

Isaacs, J.C. (2000). 'Acceptance of Genetically Modified Foods and Environmental Attitude', presented in ICABR 4th International Conference on Biotechnology, Science and Modern Agriculture, a New Industry at the Dawn of the Century, organized by International Consortium on Agricultural Biotechnology Research (ICABR), Ravelo, Italy

Isaacs, Jack Coburn (2001). 'Acceptance of Genetically Modified Foods and Environmental Attitude' Presented at 5th ICABR International Conference on Biotechnology, Science and Modern Agriculture: a New Industry at the Dawn of the Century Ravello (Italy). June 15-18, 2001

Jakobsson. K.M. and A.K. Dragun (1996). *Contingent Valuation and Endangered Species: Methodological Issues and Applications*, Edward Elgar, Cheltenham, UK

James, Sallie and Michael Burton (2001). 'Consumer Acceptance of GM Foods: Implications for Trade', ICABR conference 2001

Janis, Irving L. and Leon Mann (1977). *Decision Making: A Psychological Analysis of Conflict, Choice and Commitment,* New York: Free Press.

Jensen, Helen H. and Yen, Steven T. (1996). 'Food Expenditures Away from Home by Type of Meal', *Canadian Journal of Agricultural Economics*; 44(1): 67-80.

Johansson, Maria Vredin (1999). 'Valuing a Peripheral Environmental Amenity. The Swede's WTP for the survival of the African Elephant', Phd chapter, Dep. of Economics, Umea University, Sweden.

Johansson, Maria, V. (1999). Determinants of Charitable Giving. Evidence from Hypothetical data on willingness to pay Working Paper Department of Economics, Umea University

Johansson, P.0. (1992). 'Altruism in Cost-Benefit Analysis' *Environmental and Resource Economics*, vol. 2, pp. 605-613.

Johansson, P.-O. (1991). Valuing Environmental Damage. In Helm, D. (ed.). *Economic Policy Towards the Environment.* Blackwell: Oxford.

Johnson, B.K. *et al.* (2000). The value of public goods generated by a major league sports team: the CV approach, Paper Presented at the Western Economic Association International Meeting, Vancouver, BC 1 July 2000.

Johnson, F. Reed *et al* (2001). 'Role of Knowledge in Assessing Non-use Values for Natural Resource Damages', *Growth and Change*, 32(1): 43-68.

Johnson, F. Reed, Melissa Ruby Banzhaf, William H. Desvousges (2000). Willingness to pay for improved respiratory and cardiovascular health: a multiple-format, stated-preference approach, *Health Economics*, Volume 9, pp. 295-317

Johnson, F.R., and W.H. Desvousges. (1997). Estimating Stated Preferences with Rated-pair Data: Environmental, Health, and Employment Effects of Energy Programs. *Journal of Environmental Economics and Management* 34:79-99.

Johnson, N.L. (1949). 'Systems of Frequency Curves Generated by Methods of Translation' *Biometrica*, 36, pp. 149-176.

Jones, A. and J. Posnett (1991). 'Charitable Donations by UK Households: Evidence from the Family Expenditure Survey', *Applied Economics*, 70, pp. 543-52

Jones, A. M. and S.T. Yen (1994). 'A Box-Cox Double Hurdle Model', *IFS Working Paper Series, No. W94/6*

Jones, A.M (1989). 'Double Hurdle Model of cigarette consumption', *Journal of Applied Econometrics*, 4, pp.23-39

Jones, A.M (1992). 'A Note on Computation of the Double-Hurdle Model with Dependence with an Application to Tobacco Expenditure', *Bulletin of Economic Research,* 44(1): 67-74.

Jones, A.M. (1989). The UK Demand for Cigarettes 1945-1986, A double-Hurdle Approach, *Journal of Health Economics*, 8, pp.133-141

Jones-Lee, M.W. (1992). 'Paternalistic Altruism and the Value of Statistical Life' *Economic Journal*, 102, pp. 80-90.

Jorgensen, B.S. and Geoffrey J. Syme, (2000). Protest responses and willingness to pay: attitude toward Paying for stormwater pollution abatement, *Ecological Economics* 33 (2000). 251–265

Jorgensen, Bradley S. Mathew A. Wilson, Thomas A. Heberlein (2001). 'Fairness in the contingent valuation of environmental public goods: attitude toward paying for environmental improvements at two levels of scope', *Ecological Economics* (36).1, pp. 133-148

Jorgensen, Bradley S., *et al.*, (1999). 'Protest Responses in Contingent Valuation', *Environmental and Resource Economics,* 14(1): 131-50.

Kaheneman, D *et al* (1999). 'Economic Preferences or attitude expressions? An analysis of dollar responses to public issues', *Journal of Risk and Uncertainty*, 19, (1-3): 203-235

Kahneman, D. and J. Knetsch (1992). 'Valuing Public Goods: The Purchase of Moral Satisfaction', *Journal of Environmental Economics and Management* 22, 55-70.

Kamakura, W. and G. Russell. (1989). A probabilistic choice model for market segmentation and elasticity structure. *Journal of Marketing Research* 26:379-390.

Kamaldeen, S and D.A. Powell (2000). 'Public Perceptions of Biotechnology', Food Safety Network Technical Report #17, Department of Plant Agriculture, University of Guelph

Karni, E. and A. Schwarz (1977). 'Search Theory: The Case of Search with Uncertain

Recall,' *Journal of Economic Theory*, 16 (October): 38–52.

Karppinen, H. (2000). 'Forest values and the objectives of forest ownership', METLA working paper

Kenyon, W. and Hanley, N (2000). 'Economic and participatory approaches to environmental evaluation'. Discussion paper 00-15, Economics Department, University of Glasgow.

Kiesler, Charles A. (1966)., 'Conflict and Number of Choice Alternatives,' *Psychological Reports*, 18, 603–610.

Kimhi, Ayal (1999). 'Double-Hurdle and Purchase-Infrequency Demand Analysis: A Feasible Integrated Approach', *European Review of Agricultural Economics*, 26(4): 425-42.

Kohn, Robert E. (1993). 'Measuring the Existence Value of Wildlife: Comment,' *Land Economics*; 69(3): 304-08.

Kontoleon A, T. Swanson, M. Yabe (2003). *Consumer Resistance to GM foods in the European Union*, Report for the BioEcon project, F5, European Commission.

Kontoleon, A (1996). Determinants of WTP for Endangered Species: A meta-analysis of contingent valuation studies, *MPhil Dissertation, Faculty of Economics and Politics, University of Cambridge.*

Kontoleon, A and T. Swanson (2002). 'Motivating Existence Value' in Daniel Bromley and Jouni Paavola (Eds.). *Economics, Ethics, and Environmental Policy: Contested Choices*, Blackwell Publishers, 2002.

Kontoleon, A., R. Macrory, and T. Swanson (2002). 'Individual Preference Based Values and Environmental Decision Making: Should Valuation have its day in Court?', Research in Law and Economics, 20, 177-214

Koonts, F. (1995)., 'Wild Animal Acquisition Ethics for Zoo Biologists', in Norton,Bryan G., Michael Hutchins, Elizabeth F. Stevens, and David Ehrenfeld (Eds.). (1994). *Ethics on the Ark : Zoos, Animal Welfare and Wildlife Conservation*, Washington :Smithsonian Institution Press (pp.127-145).

Kopp, R. and V.K Smith (1989). Benefit Estimation Goes to Court: The case of natural damage assessments, Journal of Policy Analysis and Management, 8: 593-612.

Kopp, R.J. (1991). 'The Proper Role Of Existence value in Public Decision Making'. *Recourses for the Future, Discussion Paper QE 91-17.*

Kopp, R.J. and Smith, V.K. (1993). Natural Resource Damage Assessment: The Road Ahead. In Kopp, R.J. and Smith, V.K. (eds.). *Valuing Natural Assets: The Economics of Natural Resource Damage Assessment*. Resources for the Future: Washington, D.C.

Kopp, Raymond J. (1992). 'Ethical Motivations and Non use Values' *Resources for the Future Discussion Paper QE92*-10 Washington DC: Resources for the Future

Kopp, Raymond J. (1992). 'Why Existence Value Should Be Used in Cost-Benefit Analysis', *Journal of Policy Analysis and Management*, 11(1): 123-30.

Kopp, Raymond J. and V. K. Smith, eds. (1993). *Valuing Natural Assets.* Washington, D.C.: Resources for the Future.

Koppelman, F. and J. Hauser (1979). Destination Choice for Non-Grocery-Shopping Trips. *Transportation Research Record,* 673: pp. 157-165.

Kotchen, Matthew J. and Stephen D. Reiling (2000). 'Environmental attitudes, motivations, and contingent valuation of nonuse values: a case study involving endangered species', *Ecological Economics,* 32, 93–107

Kriström, B. (1997). 'Spike Models in Contingent Valuation', *American Journal of Agricultural Economics*, 79 (3): 1013-23

Krutilla, J. (1967). 'Conservation Reconsidered', *American Economic Review*, 57 (4): 777-786.

Kuperis, P.A., Veeman, M. M. and W.L. Adamowicz (1999). 'Consumer's Responses to the Potential Use of Bovine Somatotrophin in Canadian Dairy Production Canadian' *Journal of Agricultural Economics,* 47(2): 151-63.

Kwak, Seung Jun, Lee, Junsoo and Russell, Clifford, S. (1997).Dealing with Censored Data from Contingent Valuation Surveys: Symmetrically-Trimmed Least Squares Estimation, Southern Economic Journal, 63(3): 743-50.

Lancaster, K. (1971). *Consumer demand: a new approach.* New York: Columbia University Press.

Langford et al (2001). Use and Non-use values for conserving endangered species: the case of the Mediterranean monk seal, EAERE conference 2001

Langford, I. *et al.* (2000). 'A cognitive social psychological model for predicting individual risk perceptions and preferences', *CSERGE working paper GEC 2000-09.*

Langford, I.H., Georgiou, S., Bateman, I.J., Day, R.J. and Turner. R.K. (forthcoming 2003). Public perceptions of health risks from polluted coastal bathing waters: A mixed methodological analysis using cultural theory, *Risk Analysis*, in press.

Langford, I.H., Georgiou, S., Bateman, I.J., Day, R.J. and Turner. R.K. (1998). A cultural theory analysis of public perceptions of health risks from polluted coastal bathing waters, *CSERGE Global Environmental Change Working Paper 98-20*, Centre for Social and Economic Research on the Global Environment, University of East Anglia and University College London.

Larson, D.M. and Loomis J.B. (1994). 'Separating Marginal Values of Public Goods From Warm Glows in Contingent Valuation Studies.' Department of Agricultural Economics, University of California, Davis.

Larson, D.M.(1992). 'Can Non Use Value be Measured from Observable Behavior?' *American Journal of Agricultural Economics* (proceedings) 74, pp. 1114-1120

Latvala, Terhi and Jukka Kola (2000). Consumers' Willingness to Pay for Information about Food Safety and Quality: Case Beef, IAMA World Food and Agribusiness Congress Consumers, Technology & Environment: Creating Opportunity and Managing Risk June 24-28, 2000 Chicago

Layton, D.F (2000). 'Random Coefficient Models for Stated Preference Surveys' Journal of Environmental Economics and Management, 40, pp.21-36.

Layton, D.L and G. Brown (2000). 'Heterogeneous preferences regarding global climate change'. *The Review of Economics and Statistics*, 82(4):616-624.

Layton, David F., Gardner Brown, and Mark Plummer. (1999). 'Valuing Multiple Programs to Improve Fish Populations,' Working Paper

Leader-Williams, Nigel and Holly T. Dublin (2000). 'Charismatic megafauna as 'flagship species', in Entwistle, A and Nigel Dunstone (Eds.). *Priorities for the Conservation of Mammalian Diversity: Has the Panda had its Day*, Cambridge, CUP, pp. 52-81

Lin, C.-T. J. and J. W. Milon. (1993). 'Contingent Valuation of Health Risk Reductions for Shellfish Products'. *Valuing Food Safety and Nutrition*, Proceedings, The NE-165 Regional Research Project, Alexandria, June 2-4, 1993.

Lin, Kuan-Pin (2000). *Computational Econometrics: GAUSS Programming for Econometricians and Financial Analysts,* Mimeo

Lindsey, G. (1994). 'Market models, protest bids and outliers in contingent valuation', *Journal of Water resource Planning and Management*, 120, 121-129

Little, R.J.A. and Rubin, D.B. (1987). Statistical analysis with missing data. New York: Wiley.

Liu, Jianguo, Marc Linderman, Zhiyun Ouyang, Li An, Jian Yang, and Hemin Zhang (2001). 'Ecological Degradation in Protected Areas: The Case of Wolong Nature Reserve for Giant Pandas', *Science*, 6 April 2001, Vol. 292, pp.98-101.

Lockwood, M. (1999). Preference Structures, Property Rights, and Paired Comparisons. *Environmental and Resource Economics* 13: 107-122.

Lockwood, Michael (1997). 'Integrated value theory for natural areas', *Ecological Economics*, 20(1): 83-93

Loftin, R. (1995)., 'Captive Breeding of Endangered Species', in Norton,Bryan G., Michael Hutchins, Elizabeth F. Stevens, and David Ehrenfeld (Eds.). (1994). *Ethics on the Ark: Zoos, Animal Welfare and Wildlife Conservation*, Washington : Smithsonian Institution Press (pp.164-180).

Long, M.F. ((1967). 'Collective consumption services of individual consumption goods: Comment', *Quarterly Journal of Economics*, 81, pp.351-352

Loomis, J. (1990). 'Comparative reliability of the dichotomous choice and open-ended techniques in contingent valuation', *Journal of Environmental Economics & Management*, 18(1): pp. 78-87.

Loomis, J. and A.G. Caban (1988). A Willingness to pay for function for protecting acres of spotted owl habitat, *Ecological Economics*, 25, pp.315-322

Loomis, J. *et al* (1993). 'Some Empirical Evidence on Embedding Effects in Contingent Valuation of Forest Protection', *Journal of Environmental Economies and Management*, 24, pp. 45-55.

Loomis, J.B. (1988). 'Broadening the concept and measurement of existence value', *Northeastern Journal of Agricultural Resource Economics*, 17, pp.23-29.

Loomis, J.B. and K. Giraud (1997). *Economic Benefits of Endangered Fish and Wildlife Species: Literature Review and Case Study of Values for Preventing Extinction of Fish*

Species, Department of Agr and Resource Economics, Colorado State University, Mimeograph: 45pp.

Loomis, John, B. (2000). 'Contingent valuation Methodology and the US Institutional Framework' in Valuing the Environment Preferences, Bateman, I.; Willis, K., eds. Oxford University Press.

Loomis, John, B. and Douglas, S. White, (1996). 'Economic Benefits of Rare and Endangered Species: Summary and Meta-analysis', *Ecological Economics* 18(3): 197-206.

Loureiro, M. L., McCluskey, J. J. Mittelhammer, R. C. (2001). 'Assessing Consumer Preferences for Organic, Eco-labeled, and Regular Apples', *Journal of Agricultural and Resource Economics*, 26 (2): 404-416

Louviere, J.J. (1988). *Analyzing Decision Making: Metric Conjoint Analysis*, Newbury Park, CA: Sage Publications, Inc.

Louviere, Jordan J. and George Woodworth (1983). 'Design and Analysis of Stimulated Consumer Choice Experiments or Allocation Experiments: An Approach Based on Aggregate Data,' *Journal of Marketing Research, 20,* (November). pp. 350-367

Louviere, Jordan J., Hensher, David A., J. D. Swait, W. Adamowicz (2000). *Stated Choice Methods: Analysis and Applications*, Cambridge, Cambridge University Press.

Luce, Mary Frances (1998). 'Choosing to Avoid: Coping with Negatively Emotion-Laden Consumer Decisions,' *Journal of Consumer Research*, 24 (March): 409-433.

Lusk, J.L. *et al.* (2001). 'In store valuation of steak tenderness' *American Journal of Agricultural Economics*, 83(3): 539-550

Lusk, Jayson L. and Darren Hudson (forthcoming 2003). 'Willingness-to-Pay Estimates and Their Relevance to Agribusiness Decision Making' *Review of Agricultural Economics*

Lusk, Jayson L., Lisa O. House, Carlotta Valli, Sara R. Jaeger, Melissa Moore, Bert Morrow, W. Bruce Traill (2002). 'Effect of Information About Benefits of Biotechnology on Consumer Acceptance of Genetically Modified Food: Evidence from Experimental Auctions in California, Florida, and Texas' *Working Paper*

Lynn, Peter and Denise Lievesley. (1991). *'Drawing General Population Samples In Great Britain'*. London, UK. Social & Community Planning Research. pp. 13-17.

Macalister, Elliott et al (2001). Study On The Valuation And Restoration Of Biodiversity Damage For The Purpose Of Environmental Liability, Final report of project B4-3040/2000/265781/MAR/B3, EU Commission.

Mace, G and A. Balmford (2000). 'Patterns and processes in contemporary mammalian extinction' in Entwistle, A and Nigel Dunstone (Eds.). *Priorities for the Conservation of Mammalian Diversity: Has the Panda had its Day*, Cambridge, CUP, pp. 27-52

MacKinnon, J. & De Wulf, R. (1994). Designing protected areas for giant pandas in China. In: Miller, R.I. (ed). Mapping the Diversity of Nature. Chapman and Hall: London. 127-142.

Mackinnon, J., F. Bi, M. Qiu, C. Fan, H. Wang, S. Yuan, A. Tian, J. Li (1989). 'National Conservation Plan for the Giant Panda and its Habitat' Report Prepared for the Ministry of Forestry, P.R. China and WWF.

Macmillan, Douglas C., Nick Hanley , Lorna Philip and Begona Alvarez-Farizo (2000). Valuing the non-market benefits of wild goose conservation: A comparison of individual interview and group-based approaches University of Aberdeen, University of Glasgow.

Madalla, G.S., (1987). 'Limited dependent variable models using panel data', *Journal of Human Resources*, 22, 307–338.

Madanat, S.M., C.Y.D. Yang, Y-M Yen (1995). Analysis of Stated Route Diversion Intentions Under Advanced Traveler Information Systems Using Latent Variable Modeling. *Transportation Research Record* 1485: pp. 10-17.

Maddala, G.S (1983). *Limited Dependent and Qualitative Variables in Econometrics*, Cambridge University Press, Cambridge.

Magin, C.D. *et al* (1994). 'Species extinctions, endangerment and captive breeding', in Olney, P.J.S. , G.M. MacE, and A.T.C. Feistner (Eds.). (1994). *Creative Conservation : Interactive Management of Wild and Captive Animals*, London: Chaprman & Hall.

Maguire, Kelly B. Shiferaw Gurmu and Laura O. Taylor (forthcoming 2003). 'Using Hurdle Models to Evaluate Open-Ended Willingness to Pay Questions: An Application to Tests of Mode and Subject Pool Effects in Experimental Tests of Contingent Valuation', Forthcoming *Environmental and Resource Economics*

Maki, Atsushi and Nishiyama, Shigeru (1996). 'An Analysis of Under-Reporting for Micro-data Sets: The Misreporting or Double-Hurdle Model', *Economics Letters*, 52(3): 211-20.

Mäler, K. G. (1974). *Environmental Economics: A Theoretical Inquiry*, Johns Hopkins Press, Baltimore, MD

Mangione, W. (1999). *Mail Surveys: Improving the Quality*, Applied Social Research Methods Series, Volume 40, London, SAGE Publications.

McConnell (1990). Models for referendum Data: The structure of DC models for contingent valuation *Journal of Environmental Economics and Management* , 18 (1): 19-34.

McConnell, K.E. (1983). 'Existence and Bequest Value' in Robert D. Rowe and L. G. Chestnut (Eds.)., *Managing Air Quality and Scenic Resources at National Parks and Wilderness Areas*. Boulder. Colorado: Westview Press

McConnell, K.E. (1997). 'Does Altruism Undermine Existence Value?', *Journal of Environmental Economics and Management*, 32(1): 22-37.

McCutcheon, A.L. (1987). *Latent Class Analysis*. Sage University Papers Series: Quantitative Applications in the Social Sciences Number 07-064. Sage Publications, Newbury Park, California.

McDonald, J.F. and Moffitt, R.A. (1980). 'The Uses of the Tobit Analysis', *Review of Economic and Statistics*, 62, pp. 318-321.

McFadden, Daniel (1974). Conditional Logit Analysis of qualitative choice behaviour, in P. Zarembka (ed). (1974). *Frontiers in Econometrics*, Academic Press, N.Y.

McFadden, Daniel (1986a). The Choice Theory Approach to Marketing Research. *Marketing Science,* 5(4): 275-297.

McFadden, Daniel (1986b). *Discrete Response to Latent Variables for Which There are Multiple Indicators*. Working paper, Massachusetts Institute of Technology.

McFadden, Daniel (1989). A Method of Simulated Moments for Estimation of Discrete Response Models without Numerical Integration. *Econometrica* 57 5: pp. 995-1026.

McFadden, Daniel (1997). *Rationality for Economists*. Presented at the NSF Symposium on Eliciting Preferences. Berkeley, California, July.

McFadden, Daniel (1999). 'Computing Willingness-to-Pay in Random Utility Models' in Melvin, James. R., Moore, James, C., Riezman, Raymond (eds). *Trade, theory and econometrics: Essays in honor of John S. Chipman*. Studies in the Modern World Economy, vol. 15. London and New York: Routledge, 1999, pp. 253-74.

McFadden, Daniel and Paul Ruud, (1994). 'Estimation by simulation', *The Review of Economics and Statistics,* 76, 591-608

McKenna & Co (1996). Study of Civil Liability Systems for Remedying Environmental Damages, Report for the European Commission.

McKinnon, K. (2000). 'Never say die: fighting species extinction', in Entwistle, A and Nigel Dunstone (Eds.). *Priorities for the Conservation of Mammalian Diversity: Has the Panda had its Day*, Cambridge, CUP, 335-353

McLachlan, G and Basford, K. (1988). *Mixture Models: Inference and Applications to Clustering*, N.Y., Marcel Dekker Inc.

McNeely, J.A. (2000). 'Practical approaches for including mammals in biodiversity conservation' in Entwistle, A and Nigel Dunstone (Eds.). *Priorities for the Conservation of Mammalian Diversity: Has the Panda had its Day*, Cambridge, CUP, 355-367

Meacham, Cory (1997). *How the Tiger Lost Its Stripes: An Exploration into the Endangerment of a Species,* Harcourt Brace and Company, New York. 288 pp.

Meghir. C. (2000). Micro-econometrics, *Bloomsbury Programme, UCL, Spring 2001.*

Menghu, W. and Tieqin, H. (eds.). (1989). *National Conservation Management Plan for the Giant Panda and its Habitat: Sichuan, Shaanxi and Gansu Provinces*, The People's Republic of China. Joint Report of the WWF & Ministry of Forestry of the People's Republic of China.

Metrick, A. and M. Weitzman (1996). 'Patterns of Behavior in Endangered Species Preservation', *Land Economics*, 71 (1): pp.1-16

Milgrom, P. (1993). 'Is Sympathy an Economic Value? Philosophy, Economics, and the Contingent Valuation Method', in Hausman, J.A. ed. *Contingent Valuation: A Critical Assessment.*

Miller, J.R. (1981). Irreversible Land Use and the preservation of endangered species, Journal of Environmental Economics and Management , 81(1)., 19-26

Miller, J.R., and F.C. Menz (1979). Some Economic considerations for wildlife preservation, *Southern Economic Journal*, 45, pp. 718-729

Mills, J., S. Chan and A. Ishihara, (1995). *The Bear Facts: The East Asian Market for Bear Gall Bladder*, Cambridge: Traffic East Asia

Mitchell, R.C. and Carson, R.T. (1989). *Using Surveys to Value Public Goods: The Contingent Valuation Method;* Johns Hopkins University Press.

Mitchell, R.C. and Carson, R.T. (1995). 'Current Issues in the Design, Administration, and Analysis of Contingent Valuation Surveys,' in *Current Issues in Environmental Economics*, Johansson, P.O., Kristrom, B., and Maler, K.G. (Eds)., Manchester University Press, 1995

Montgomery, Claire A. Jr., Gardner M. Brown, Darius M. Adams (1994). The Marginal Cost of Species Preservation: The Northern Spotted Owl, *Journal of Environmental Economics and Management*, 26 (2): 111-128

Montgomery, Henry (1989). 'From Cognition to Action: The Search for Dominance in Decision Making,' In *Process and Structure in Human Decision Making* (eds. Henry Montgomery and Ola Svenson)., New York: John Wiley and Sons.

Moon, W. *et al.* (2000). Willingness to pat for Environmental Practices: Implications for Eco-Labelling, *Land Economics*, Volume, 78, pp. 88-102

Moon, Wanki and Siva Balasubramanian (2001). 'Contingent Valuation of Nonbiotech Foods: Payment Card Interval Data Approach' *Presented at 5th International Conference on Biotechnology, Science and Modern Agriculture, a New Industry at the Dawn of the Century, organized by International Consortium on Agricultural Biotechnology Research (ICABR)., Ravelo, Italy*

Mooney, Sian and Klein, K. K.(1999). 'Environmental Concerns and Risks of Genetically Modified Crops: Economic Contributions to the Debate', *Canadian Journal of Agricultural Economics*, 47(4): 437-44.

Moran D. (2000). Accounting for Non-Use value in options appraisal: environmental benefits transfer and low flow alleviation, in *Economic Valuation of Water Resources: Policy and Practice*, CIWEM.

Moran, D. and D. Pearce. (2001), 'Economic Valuation: Benefits Transfer', Chapter 8 in 'Handbook on the Applied Valuation of Biological Diversity,' *Organization for Economic Co-operation and Development,* Paris, France.

Morey, E.R. *et al.* (2002). 'Valuing reduced deposition injuries to cultural resources: marble monuments in Washington' in Navrud, S and R. Ready (Eds.). *Valuing Cultural Heritage*, Edward Elgar, Cheltenham, UK.

Morey, E.R., (1999). Tow RUMs Uncloaked: nested-logit models of site choice and nested-logit models of participation and site choice. *Valuing the Environment Using Recreation Demand Models*, C. Kling and J. Herriges, eds. Edgar Elgar Publishing Ltd.

Morey, E.R., and K.G. Rossmann (2002). 'Using Stated-Preference Questions to Investigate Variation in Willingness to Pay for Preserving Marble Monuments: Classical Heterogeneity and Random Parameters' *Working Paper, Department of Economics, University of Colorado.*

Morey, E.R., and K.G. Rossmann. (1999). Combining Random Parameters and Classic Heterogeneity to Estimate the Benefits of Decreasing Acid Deposition Injuries to Marble Monuments in Washington, D.C. Discussion paper, Department of Economics, University of Colorado.

Morikawa, T (1989). 'Incorporating stated preference data in travel demand analysis' Phd Dissertation, Department of Civil Engineering, MIT.

Morikawa, T., M. Ben-Akiva, and D. McFadden (1996). *Incorporating Psychometric Data in Econometric Choice Models*. Working paper, Massachusetts Institute of Technology.

Morrison, M.D. and Blamey, R. K. and Bennett, J. W. (2000). 'Minimising Payment Vehicle Bias in Contingent Valuation Studies', *Environmental and Resource Economics*; 16(4): pp. 407-22.

Mourato (1999). *Essays on the measurement of environmental externalities*, Phd Thesis, Department of Economics, UCL

Mourato S. and Pearce, D. (1999). *Dealing with Low Willingness to Pay for Cultural Heritage: Statistical and Policy Implications*. Paper presented to the European Association of Agricultural and Resource Economics Conference, Oslo.

Mourato, S., Kontoleon, A. and Danchev, A. (2002). 'Preserving Cultural Heritage in Transition Economies: A Contingent Valuation Study of Bulgarian Monasteries' in S. Navrud and R. Ready (eds.). *Valuing Cultural Heritage: Applying Environmental Valuation Techniques to Historic Buildings, Monuments and Artefacts*. Edward Elgar, Cheltenham.

Muller, R.A. *et al.* (2001). Inferring WTP for Health Attributes of Air Quality using Information on Ranking of Alternatives and Cognitive Ability of Respondents, Working Papers Series 2001-02, Department of Economics, McMaster University, Ontario Canada.

Munro, A and N.D. Hanley (2000). Information, Uncertainty, and contingent valuation, in *Valuing the Environment Preferences*, Bateman, I.; Willis, K., eds. Oxford University Press

Myers, N. (1983). *A Wealth of Wild Species*, Westview: Boulder.

Navrud, S. (2000). 'Strengths, weaknesses and policy utility of valuation techniques and benefit transfer', Invited Paper for the OECD-USDA workshop *The Value of Rural Amenities: Dealing with Public Goods, Non-Market Goods and Externalities,* Washington, D.C., June 5-6, 2000.

Navrud, S., (2002) 'Comparing Valuation Exercises in Europe and the United States - Challenges for Benefit Transfer and Some Policy Implications,' Chapter 4 in 'Valuation of Biodiversity Benefits - Selected Studies,' published by the Organization for Economic Co-operation and Development, Paris, France.

Navrud, Stale (1992). *Pricing the European Environmental*, Oxford University Press

Navrud, Stale and Pruckner, Gerald. J. (1997). 'Environmental Valuation-To Use or Not to Use? A Comparative Study of the United States and Europe', *Environmental and Resource Economics*, 10(1)., pp. 1-26.

Nelson, Carl H. (2001). 'Risk Perception, Behavior, and Consumer Response to Genetically Modified Organisms.' *American Behavioral Scientist.* 44 : 1371 – 1388.

Nelson, G *et al.* (1999). The Economics and Politics of GMOs in Agriculture: Implications for WTO 2000, Bulletin 809, University of Illinois

Newell, A. and Herbert A. Simon (1972)., *Human Problem Solving,* Englewood Cliffs, NJ: Prentice Hall.

Norton, Bryan G (1994). 'Caring for Nature: A broader look at animal stewardship' in Norton,Bryan G., Michael Hutchins, Elizabeth F. Stevens, and David Ehrenfeld (Eds.). (1994). *Ethics on the Ark: Zoos, Animal Welfare and Wildlife Conservation,* Washington : Smithsonian Institution Press (pp.121-126).

Norton, Bryan G. (1982). 'Environmental Ethics and Non-human Rights' *Environmental Ethics,* vol. 4, pp. 17-36.

Norton, Bryan G., Michael Hutchins, Elizabeth F. Stevens, and David Ehrenfeld (Eds.). (1994). *Ethics on the Ark: Zoos, Animal Welfare and Wildlife Conservation,* Washington : Smithsonian Institution Press

Novak, T *et al.* (1992). 'Richness curves for evaluating market segmentation', *Journal of Marketing Research*, 29, 254-267

Nunes, P. (2001). Using Factor Analysis to Identify Consumer references for the Protection of a Natural Area in Portugal (forthcoming this Winter in a Special Issue of the European Journal of Operational Research

Nunes, P. and E. Schokkaert (2002). ' Warm glow and embedding in contingent valuation' under review in Journal of Environmental Economics and Management.

Nyborg, Karine (2000). Homo Economicus and Homo Politicus: interpretation and aggregation of environmental values, *Journal Of Economic Behavior And Organization,* 42 (3): 305-322.

Olney, P.J.S. , G.M. MacE, and A.T.C. Feistner (Eds.). (1994). *Creative Conservation : Interactive Management of Wild and Captive Animals*, London: Chaprman & Hall

Olsen, G.D. and Swait, J. (1998). Nothing is Important, Working Paper, September 1997, Advanis Inc., 12 W University Ave. #205, Gainesville, FL 32601.

Opaluch, J.J. and T.A. Grigalunas (1992). 'Ethical values and personal preferences as determinants of non use values: Implications for natural resource damage assessment' Staff paper, Department of Resource Economics, University of Rhode Island

Passmore, John, (1974). *Man' s Responsibility for Nature*, Charls Scribner's Sons, NY.

Pate, Jennifer and Loomis, John (1997). 'The Effect of Distance on Willingness to Pay Values: A Case Study of Wetlands and Salmon in California', '*Ecological Economics*' 20(3): 199-207.

Payne, John W., *et al.* (2000). Valuation of Multiple Environmental Programs, '*Journal of Risk and Uncertainty*' 21(1): 95-115.

Payne, John W., James R. Bettman and Eric J. Johnson (1988). 'Adaptive Strategy Selection in Decision Making,' *Journal of Experimental Psychology: Learning, Memory and Cognition,* 14, 534-552.

Payne, John W., James R. Bettman, and Eric J. Johnson (1992). 'Behavioral Decision Research: A Constructive Processing Perspective,' *Annual Review of Psychology*, 43, pp. 87-131

Pearce, D.W. (2000). 'Cost-Benefit Analysis and Environmental Policy' in Dieter Helm (ed). Environmental Policy: Objectives, Instruments, and Implementation, Oxford, OUP

Pearce, David W. and Turner, R. Kerry (1990). *Economics of Natural Resources And The Environment*, Baltimore: Johns Hopkins University Press.

Pearce, David W., Corin G. Pearce and Charles Palmer (eds.). (2002). *Valuing Environmental Benefits. Volume I: Case Studies from the Developing World*, Edward Elgar, Cheltenham.

Penn, T. A (2000). Summary of the Natural Resource Damage Assessment regulations under the United States Oil Protection Act, NOAA Report

Peters, T *et al.* (1995). Influence of choice set considerations in modeling the benefits from imrpoved water quality, *Water Resource Research*, 31(7): 1781-1787

Phaneuf, D.J., C.L. Kling and J.A. Herriges. (1998). 'Valuing Water Quality Improvements Using Revealed Preference Methods when Corner Solutions are Present.' *Discussion paper, Iowa State University.*

Piper, S. and W.E. Martin, (2001), 'Evaluating the Accuracy of the Benefit Transfer Method: A Rural Water Supply Application in the U.S.A.,' *Journal of Environmental Management,* 63, 223-235.

Plourde, C. (1975). Conservation of extinguishable species, *Natural Resource Journal*, 15 (4): 791-797.

Poirier, Dale J. (1978). The Use of the Box-Cox Transformation in Limited Dependent Variable Models Journal-of-the-American-Statistical-Association; 73(362): 284-87

Pollack, R.A. and Wales (1991). 'The likelihood Dominance Criterion: A new Approach to Model Selection' *Journal of Econometrics*, 47, 227-242

Portney, P. (1994). 'The contingent valuation debate: why economists should care?' *Journal of Economic Perspectives*, 8, (4): pp.3-17

Posner, Richard A. (1972). *Economic Analysis of Law*, Boston, Little Brown.

Powell, J.L. (1988). 'Symmetrically Trimmed Least Squares Estimation for Tobit Models', *Econometrica*, 54 (6): 1435-1460.

Prendergast, J. R. , R. M. Quinn, J. H. Lawton, B.C. Eversham and D.W.Gibbons, (1993). 'Rare species, the coincidence of diversity hotspots and conservation strategies'. *Nature* (365). 335-337

Priez, France and Jeanrenaud, Claude (1999). 'Human Costs of Chronic Bronchitis in Switzerland', *Swiss Journal of Economics and Statistics*, 135(3): 287-301.

Pudney, S. (1989). *Modelling Individual Choice. The Economics of Corners, Kinks and Holes*, Basil Blackwell, Oxford

Quiggin, John (1997). 'Altruism and Benefit-Cost Analysis', *Australian Economic Papers,* 36(68): 144-55.

Randall A (1993). Total and Non-use values, in *Measuring the demand for environmental quality* edited by John B. Braden, Charles D. Kolstad, Elsevier Science Pub. Co, (c1991). NY

Randall, A. and J.P. Hoehn. (1996). 'Embedding in Market Demand Systems.' *Journal of Environmental Economics and Management*, 30, pp. 369-380.

Randall, A. and J.R. Stoll (1983).'Existence value in a Total Valuation Framework' in Robert D. Rowe and L. G. Chestnut (Eds.)., *Managing Air Quality and Scenic Resources at National Parks and Wilderness Areas*. Boulder. Colorado: Westview Press.

Randall, Alan (1991). 'Total and Non-use Values', in Braden, John B.; Kolstad, Charles D., eds. *Measuring the demand for environmental quality.* Contributions to Economic Analysis, no. 198, Amsterdam; Oxford and Tokyo: North Holland; distributed in the U.S. and Canada by Elsevier Science, New York, 1991, pages 303-21.

Randall, Alan (1997). 'Whose Losses Count? Examining Some Claims about Aggregation Rules for Natural Resources', *Contemporary Economic Policy*, 15(4): October 1997, pages 88-97.

Randall, Alan (2002). 'Benefit-Cost Considerations Should be Decisive When There is Nothing More Important at Stake' in *Economics, Ethics, and Environmental Policy: Contested Choices*, Daniel Bromley and Jouni Paavola (eds.)., Blackwell Publishers (2002 forthcoming).

Ready, E., and Navrud, S., Day, B., Duborg, R., Machado, F., Mourato, S., Spanninks, F., Rodrquez, M., (2002). 'Benefit Transfer in Europe: Are Values Consistent Across Countries?' W*orking paper supported by the European Union's Environment and Climate Research Programme.*

Ready, R, *et al.* (1996). 'Differences between continuous and Discrete Contingent Value Estimates', *Land Economics*, 72 (3): 397-411

Ready, R., Buzby, J. and Hu, D. (1996). 'Differences between continuous and discrete contingent valuation estimates', *Land Economic*s, 72(3): pp. 397-411.

Ready, Richard C., and Kimberley Henken. (1999) '*Optimal Self Protection from Nitrate Contamination', American Journal of Agricultural Economics,* 81(May): 321-334.

Reaves, Dixie Watts Randall A. Kramer, and Thomas P. Holmes (1999). 'Does Question Format Matter? Valuing an Endangered Species', *Environmental and Resource Economics* 14: 365-383.

Rekola, M. *et al* (2000). Incommensurable preferences in contingent valuation: commitments to nature and property rights, presented in EAERE conference Crete 2000.

Rekola, Mika and Pouta Eija (2001). Lexicographic Preferences In Contingent Valuation – Theoretical Framework And Measurement Experiment, A Paper To Be Presented In The EAERE 2001 At The university Of Southampton, Southampton, U.K. 8 January, 2001

Revelt, D. and K. Train (1998). 'Mixed logit with repeated choices: Households' choice of appliance efficiency level', *Review of Economics and Statistics* 53:647-657.

Reynolds, A and J.S. Shonkwiler (1991). 'Testing and Correcting for Distributional Misspecifications in the Tobit Model.' Empirical Economics, 16 (1991). pp. 313-323.

Ritov, Ilana and Jonathan Baron (1990). 'Reluctance to Vaccinate: Omission Bias and Ambiguity,' *Journal of Behavioral Decision Making*, 3 (December): 263–277.

Roe, Brian, Kevin J. Boyle , and Mario F. Teisl (1996). 'Using Conjoint Analysis to Derive Estimates of Compensating Variation', *Journal of Environmental Economics and Management*, 31 (2):145-159.

Rolfe, John (1999). ' Ethical Rules and the Demand for Free Range Eggs', *Economic Analysis and Policy*; 29(2): 187-206.

Rolfe, John, Bennett, Jeff; and Louviere, Jordan (2000). 'Choice Modelling and Its Potential Application to Tropical Rainforest Preservation', *Ecological Economics*, 35 (2): 289-302.

Rollins, Kimberly and Lyke, Audrey,(1998). 'The Case for Diminishing Marginal Existence Values', *Journal of Environmental Economics and Management*, 6(3):324-44.

Romer A, U. *et al.* (1998). 'Revealing Preferences for Reductions of Public Risk: An Application of the CV Approach', *Journal of Environmental Planning and Management*, 41(4): 4777-503.

Roosen, Jutta *et al.* (1998). 'Consumers' Valuation of Insecticide Use Restrictions: An Application to Apples', *Journal of Agricultural and Resource* Economics, 23(2): 367-84.

Rosbergen, Edward, Pieters, Rik; and Wedel, Michel (1997). ' Visual Attention to Advertising: A Segment-Level Analysis', *Journal of Consumer Research*, 24(3): 305-14.

Rosenberger, R. and J.B. Loomis. (2001). 'Benefit Transfer of Outdoor Recreation Use Values,' *U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station,* Fort Collins, Coldorado.

Rosenthal, Donald H. and Nelson, Robert H. (1992). 'Why Existence Value Should Not Be Used in Cost-Benefit Analysis', *Journal of Policy Analysis and Management*, 11(1): 116-22.

Rowe, R. and Shaw, D. and Schulze, W. (1992). 'Nestucca Oil Spill', in J. Ward and J. Duffield (eds.)., *Natural Resource Damages: Law and Economics*, John Wiley, New York.

Sadler, M (2000). 'GM Foods: Past, present and future. Industry's approach, consumer attitudes, expectations for the future', *IGD Technical Publication.*

Sagoff, M. (1994). 'Should Preferences Count?', *Land Economic*, 70(2): 127-44.

Sagoff, M. (1998). Aggregation and deliberation in valuing environmental public goods: A look beyond contingent pricing, *Ecological Economics*, Volume 2 (2-3):213-230

Salomon, I. and M. Ben-Akiva. (1983). The use of the life-style concept in travel demand models. *Environmental and Planning A* 15:623-638.

Scarpa, R., G. Philippidis, F. Spalatro. (2001). 'Product-Country Images' and Preference Heterogeneity for Mediterranean Food Products: A Random Utility Analysis, Forthcoming.

Schade, D.A. and Payne, J.W. (1994). 'How people respond to contingent valuation questions: A verbal Protocol Analysis of Willingness to Pay for Environmental Regulation', *Journal of Environmental Economics and Management*, 26, 88-109.

Schaller, G.B. (1993). *The Last Panda*. The University of Chicago Press.

Schilderinck, J. H. F. (1978). *Regression and factor analysis applied in econometrics*, Second Edition. Leiden: Martinus Nijhoff Social Sciences Division

Schmidt, P. and R. Strauss (1975). The predictions of occupation using multinomial logit models. *International Economic Review* 16:471-486.

Schulze, W.D, et al (1998). 'Embedding and calibration in measuring non-use values', *Resource and Energy Economics* 20, p. 163-178

Schulze, William D.; d'Arge, Ralph C.; Brookshire, David S.(1981). 'Valuing Environmental Commodities: Some Recent Experiments', *Land Economics*; 57(2): 151-72.

Sen, A. K. (1977). 'Rational Fools: A Critique of the Behavioral Foundations of Economic Theory', *Philosophy and Public Affair*s, Vol. 6, pp. 317-344.

Sen, Amartya (2000). 'The Discipline of Cost-Benefit Analysis', *Journal of Legal Studies*, 29(2) pp. 931-52.

Shafir, Eldar (1993). 'Choosing Versus Rejecting: Why Some Options Are Both Better and Worse Than Others,' *Memory & Cognition* , 21 (July): 546-556.

Shavell, S. (1984). 'Liability for Harm Versus Regulation for Safety' Journal of Legal Studies, June, pp.357-374.

Shavell, S. (1987). *Economic Analysis of Accident Law,* Cambridge, Mass., Harvard University Press'

Shavell, S. (1993). 'Contingent Valuation of the Non-use value of Natural Resources: Implications for public policy and the Liability System' in Hausman, J.A. ed. Contingent Valuation: A Critical Assessment.

Shechter, M. and S. Freeman (1994). 'Some reflections on the Definition and Measurement of Non Use Values' in R. Pethig (ed). Valuing the Environment: Methodological and Measurement Issues, Amsterdam: Kluwer, pp. 171-194

Shechter, M., B. Reiser and N. Zaitsev (1998). 'Measuring Passive Use Value', *Environmental and Resource Economics,* vol. 12, pp.457-478

Shepard, Roger N. (1964)., 'On Subjectively Optimum Selection among Multiattribute Alternatives,' *in Human Judgement and Optimality*, ed. M. W. Shelley and G. L. Bryan, New York: Wiley.

Shonkwiler, J.S. and W.D. Shaw (1997). 'Shaken, not stirred: A finite mixture approach to analysing income effects in random utility models'. Paper Presented at the 1997 Annual Meeting of the American Agricultural Economics Association. August 2-4, Toronto, Ontario.

Shugan, Steve (1980). The Cost of Thinking. *Journal of Consumer Research*, 7:99-111.

Simonson, Itamar (1989). 'Choice Based on Reasons: The Case of Attraction and Compromise Effects,' *Journal of Consumer Research, 16*, 158-174.

Simonson, Itamar (1992). 'The Influence of Anticipating Regret and Responsibility on Purchase Decisions,' *Journal of Consumer Research*, 19 (June): 105-118.

Simonson, Itamar and Amos Tversky (1992). 'Choice In Context: Tradeoff Contrast and Extremeness Aversion,' *Journal of Marketing Research*, 29 (4): 281-96.

Simpson, D. *et al* (1996). 'Valuing Biodiversity for the Use in Pharmaceutical Research', *Journal of Political Economy*, 104, pp.163-85

Singer, Peter (1975). *Animal Liberation, Avon Books, NY*

Singer, Peter (1975). 'The fable of the fox and the unliberated animals', *Ethics*, 88, 119-25.

Slovic, Paul (1975). 'Choice Between Equally Valued Alternatives,' *Journal of Experimental Psychology: Human Perception and Performance,* 1, pp. 280-287.

Slovic, Paul (1995)., 'The Construction of Preference,' *American Psychologist*, 50 (May): 364–371.

Smith, K.V. (1987). 'Non-use values in Benefit-Cost Analysis', *Southern Economic Journal*, 54(1): 19-26.

Smith, V. K. (1992). Arbitrary values, good causes and premature verdicts, Journal of Environmental Economics and Management, 22, 71-89

Smith, V.K (1997). Time and the Valuation of Environmental Resources, Discussion Paper, 98-07

Smith, V.K and W.H. Desvousges (1986). Measuring Water Quality benefits, Boston Kluwer Nijhoff Publishers

Smith, V.K. and G.V. Houtven and S.K. Pattanayak, (2002). 'Benefit Transfer via Preference Calibration: "Prudential Algebra" for Policy,' *Land Economics,* 78 (1): 132-152.

Soderqvist, Tore (1998). Why Give up Money for the Baltic Sea? Motives for People's Willingness (or Reluctance). to Pay, *Environmental and Resource Economics*,12(2): 249-54.

Spash C. (1997). Ethics and Environmental Attitudes With Implications for Economic Valuation, *Journal of Environmental Management* (1997). 50, 403–416.

Spash, C. (2002). 'Empirical Signs of Ethical Concern in Economic Valuation of the Environmental' in D. Bromley and J. Paavola (Eds.)., *Economics, Ethics, and the Environment*, Oxford, Blackwell Publishing, pp. 205-221

Spash, Clive L (2000). 'Ecosystems, contingent valuation and ethics: the case of wetland re-creation', Ecological Economics, 34 (2): 195 - 215

Spash, Clive, L (2000). 'Ecosystems, contingent valuation and ethics: the case of wetland re-creation', Ecological Economics, 34 (2): 195 – 215.

Stephen, Frank H. (1988). *The Economics of the Law*, Harvester Wheatsheaf.

Stevens, Thomas H. *et al.* (1991). 'Measuring the Existence Value of Wildlife: What Do CVM Estimates Really Show? *Land Economics*, 67(4): 390-400.

Stewart, R.B. (1995). 'Liability for Natural Resource damages: Beyond Tort', in Revesz, R.L. and R.B., Stewart (Eds.). *Analysing Superfund: Economics, Science and Law*, RFF, Washington, 1995

Stigler, G. J. (1961). 'The Economics of Information,' *Journal of Political Economy*, 3 (June): 213–225.

Stirling, A. (1997). 'Limits to the Value of External Costs', *Energy Policy*, 25, pp.517-540.

Stirling, Bryan *et al.* (1998). Magnetic Resonance Imaging for the Investigation of Knee Injuries: An Investigation of Preferences *Health Economics*, 7 (7): pages 595-603.

Stone, C.D. (1974). *Do Trees have standing? Towards Legal Rights for Natural Objects*, Los Altos, California: William Kaufman.

Strazzera, Elisabetta Margarita Genius, Riccardo Scarpa and George Hutchinson (2001). 'The effect of protest votes on the estimates of willingness to pay for use values of recreational sites', Working Paper.

Strazzera, Elisabetta, Riccardo Scarpa, Pinuccia Calia, Guy Garrod, Ken Willis (2000). 'Modelling Zero Bids In Contingent Valuation Surveys' Working Paper

Su, Shew Jiuan B and Yen, Steven T.(1996). Microeconometric Models of Infrequently Purchased Goods: An Application to Household Pork Consumption, *Empirical Economics*; 21(4): 513-33.

Sunquis, Fiona (1995). 'End of the ark?', *International Wildlife,* November Issue, 1995.

Sutherland Ronald J. and Richard G. Walsh. (1985). 'Effect of Distance on the Preservation Value of Water Quality', *Land Economics,* 61 (3): 281-291

Swait, and W. Adamowicz (1996). 'The effect of choice environment and task demands on consumer behaviour: discriminating between contribution and confusion', *Department of Rural Economy, Staff Paper, pp. 96-09, University of Alberta, Alberta Canada.*

Swait, J and E.C. Stacey (1996). 'Consumer brand assessment and assessment confidence in models of longitudinal choice behaviour' presented at the 1996 INFORMS Marketing Sceince Conference, March 7-10, 1996, Gainesville, Florida

Swait, J and J. Sweeney (1996). 'Received value and its impact on choice behaviour in a retail setting', *Working paper, Department of Marketing, University of Florida*

Swait, J. and A. Bernardino (2000). Distinguishing taste variation from error structure in discrete choice data. *Transportation Research Part* B. 34:1-15.

Swait, J.R. (1994). 'A structural equation model of latent segmentation and product choice for cross-sectional revealed preference choice data'. *Journal of Retailing and Consumer Services* 1, pp.77-89.

Swait, J.R. (1994). A structural equation model of latent segmentation and product choice for cross-sectional revealed preference choice data. *Journal of Retailing and Consumer Services* 1:77-89.

Swait, J.R. and J.J. Louviere. (1993). The role of the scale parameter in the estimation and comparison of multinomial logit models. *Journal of Marketing Research* 30:305-314.

Swait, Joffre and Jordan Louviere (1993). The Role of the Scale Parameter in the Estimation and Comparison of Multinomial Logit Models. *Journal of Marketing Research*, 30:305-314.

Swait, Joffre and Wiktor Adamowicz (1996). The Effect of Choice Environment and Task Demands on Consumer Behavior: Discriminating Between Contribution and Confusion, Staff Paper 96-09, Department of Rural Economy, University of Alberta.

Swallow, Stephen, K. *et al.* (1994). 'Heterogeneous Preferences and Aggregation in Environmental Policy Analysis: A Landfill Siting Case', *American Journal of Agricultural Economics*; 76(3): 431-43.

Swanson, T, M and A. Kontoleon (2000). 'Why Did the protected Areas Fail the Giant Panda? The Economics of conserving endangered species in developing countries', *World Economics,* 1(4):135-148.

Swanson, T.M. (1994a). 'The Economics of Extinction Revisited and revised: A generalised framework for the analysis of the problems of endangered species and biodiversity loss', *Oxford Economic Papers*, 46, pp. 800-821

Swanson, T.M. (1994b). 'Economics and Animal Welfare: A Policy Analysis of the Live Bird Trade', CSERGE Working Paper GEC 94-09

Swanson, T.M. and Barbier, E.B. (1992). *Economics for the Wilds: Wildlands, Wildlife, Diversity and Development.* Earthscan, London

Swanson, T.M., Wang Qiwen, Andreas Kontoleon, Qiao Xuejun and Catherine Yang (2001). *The Economics of Panda Reserve Management: A Case Study of Wolong Reserve, Sichuan, China.,* Environmental Economics Working Group, China Council for International Cooperation on the Environment and Development, Maryland, USA.

Teisl, Mario F. Teisl, Mario F., B. Roe, and R.L. Hicks (2002) 'Can Eco-Labels Tune a Market? Evidence from Dolphin-Safe Labeling', *Journal of Environmental Economics and Management*, 43(3): 339-359

Tetlock, Philip E. (1985). 'Accountability: The Neglected Social Context of Judgment and Choice,' *Research in Organizational Behavior, 7*, 297-332.

Thomson, G. H., (1951). *The Factor Analysis of Human Ability*, London: University of London Press.

Titterington, D.M., A.F.M. Smith, and U.E. Makov (1985). *Statistical Analysis of Finite Mixture Distributions*. John Wiley & Sons, New York, NY.

Tobin, J (1958). Estimation of Relationships for Limited dependent variables, Econometrica, 26, pp.24-36.

Train, K. (1986). Qualitative Choice Analysis, Theory, Econometrics, and an Application to Automobile Demand, MIT Press, London

Train, K. (1998). Recreation Demand Models with Taste Differences over People, *Land Economics,* 74 (2): 230-9

Train, K., D. McFadden and A. Goett (1986). The Incorporation of Attitudes in Econometric Models of Consumer Choice. Cambridge Systematics working paper.

Train, K.E. (1997). Mixed logit models for recreation demand. In: C. Kling and J. Herriges (editors). *Valuing the Environment using Recreation Demand Models*, Edward Elgar, Lyme New Hampshire.

Trumbull, W.N (1990). Who Has Standing in Cost Benefit Analysis?, *Journal of Policy Analysis and Management*, 9 (2): 201-218

Turner, K.R (2000). 'The Place of Economic Values in Environmental Valuation' in *Valuing the Environment Preferences*, Bateman, I.; Willis, K., eds. Oxford University Press

Tversky, Amos and Eldar Shafir (1992). Choice Under Conflict: The Dynamics of Deferred Decision. *Psychological Science*, 6:358-361.

Tversky, Amos, Shmuel Sattath and Paul Slovic (1988). 'Contingent Weighting in Judgment and Choice,' *Psychological Review,* 95, 371--384.

Tyebjee, Tyzoon T. (1979). 'Response Time, Conflict and Involvement in Brand Choice,' *Journal of Consumer Research, 6,* (December): 295-304.

Unsworth, Robert. E., and Richard C. Bishop, (1994). 'Assessing Natural Resource Damages Using Environmental Annuities' *Ecological Economics*, 11: 35-41.

Van Kooten, Cornelis, G. and Erwin .H. Bulte (2000). *The Economics of Nature: Managing Biological Assets*, Oxford, Blackwell

van Ranvenswaay, Eileen. 1995. 'Valuing Food Safety and Nutrition: The Research Needs', *Valuing Food Safety and Nutrition* (Ed. by Caswell J. A.). Westview Press, Boulder, Colorado.

Van Ravensway, Eileen and J.P. Hoehn (1991). 'Contingent valuation and food safety: the case of pesticide residues in food', Staff Paper, Department of Agricultural Economics, Michigan State University

Veeman, Michele (2001). *Consumers, Public Perceptions and Biotechnology.* Working Papers, Department of Rural Economy ,University of Alberta.

Verdurme, A. and Viaene, J. (2000). Consumer beliefs and attitude towards genetically modified food: basis for segmentation and implications for communication. Submitted to *Agribusiness: An International Journal.*

Verdurme, A. Gellynk, Xavier and Viaene, J. (2001). 'Consumer segments based on acceptance of GM foods' *Paper presented at the International Conference of Agricultural Biotechnology Research. Ravello, Italy. June. 2001.*

Verdurme, Annelies and Jacques Viaene (2002). 'Public Acceptance and Communication With Regard to Genetically Modified Food' Presented at the 6th International ICABR Conference Ravello, Italy, July 11-14, 2002

Vieira, L. (1992). 'The value of service in fright transportation', Phd Dissertation, Department of Civil Engineering, MIT.

Vousden, J.J. (1973). 'Basic Theoretical Issues of Resource Depletion', *Journal of Economic Theory*, 6(2): 126-43

Vuong, Quang H.(1989). 'Likelihood Ratio Tests for Model Selection and Non-Nested Hypotheses', *Econometrica*, 57 (2): 307-333.

Walsh, R.G., J. Loomis, and R.A. Gillman (1984). 'Valuing Option, Existence, and Bequest Demands for Wilderness'. *Land Economics*, 60, pp. 14-29.

Wang, H. (1997). Treatment of 'Don't Know' Responses in CV Surveys: A random Valuation Application, *Journal of Environmental Economics and Management*, 32, (2): 219-32

Wang, Q, H., H. Jensen, and S.T.Yen (1996). 'Impact of cholesterol information on US egg consumption: evidence from consumer survey data', *Applied Economic Letters*, 3, 189-191

Ward, Kevin M., and John W. Duffield (1992). *Natural Resource Damages: Law and Economics*. New York: John Wiley & Sons, Inc.

Webster, Donna M. and Arie W. Kruglanski (1994). 'Individual Differences in Need for Cognitive Closure,' *Journal of Personality and Social Psychology*, 67 (6): 1049-1062.

Wedel, Michel and Wayne S. DeSarbo (1994). , 'A Review of Recent Developments in Latent Class Regression Models,' in *Advanced Methods of Marketing Research*, ed. Richard P. Bagozzi, Cambridge, MA: Blackwell, 352–388.

Weisbrod, B.A. (1964). 'Collective Consumption Services of Individual Consumption Goods', *Quarterly Journal of Economics*, 78(3): 471-477

Weitzman, Martin L. (1993). 'What to Preserve? An Application of Diversity Theory to Crane Conservation' *Quarterly Journal of Economics*, 108 (1):157-183.

Weitzman, Martin L. (1998). 'The Noah's Ark Problem', *Econometrica*, 66 (6): 1276

Werner, Megan (1999). 'Allowing for Zeros in Dichotomous-Choice Contingent Valuation Models', *Journal of Business and Economic Statistics*; 17 (4): 479-86.

Whitehead, J. C. (1998). 'Willingness to pay for quality Improvements: Comparative Statics and Interpretation of Contingent valuation results', *Land Economics*, 71 (2): 207-15

Whitehead, J.C. and Blomquist, G.C., (1991). 'Measuring contingent values for wetlands: effects of information about related environmental goods', Water Resources. Research. 27, 2523–2531.

Whitehead, John, C. and Thompson, Carol, Y. (1993). 'Environmental Preservation Demand: Altruistic, Bequest, and Intrinsic Motives', *American Journal of Economics and Sociology*, 52(1): 19-30.

Whittington, Dale and Duncan Macrae Jr. (1986). 'The Issue of Standing in Benefit Cost Analysis.' *Journal of Policy Analysis and Management*, 9(2): 201-218.

Wier, M and L. M .Andreson (2001). Studies on Consumer Demand for Organic Foods – A survey, Working Paper, AKF

Williams, P.H., Burgess, N.D. and Rahbek, C. (2000a). 'Flagship species, ecological complementarity, and conserving the diversity of mammals and birds in sub-Saharan Africa.' *Animal Conservation*, 3: 249-260.

Williams, P.H., Burgess, N.D. and Rahbek, C. (2000b). 'Assessing large 'flagship species' for preserving the diversity of sub-saharan mammals', in Entwistle, A and Nigel Dunstone (Eds.). *Priorities for the Conservation of Mammalian Diversity: Has the Panda had its Day*, Cambridge, CUP, pp. 85-99

Willing, R.D (1976). 'Consumer Surplus Without Apology', *American Economic Review*, 587-97

Winter, M., Fry, C, and Carruthers, S. P.(1989). ' Social Costs of Regulation of Primary Industry: An Application to Animal Welfare Regulation of the Victorian Pig Industry', *Food Policy*, 23(3-4)., June-Aug. 1998, pages 305-23.Alexander Robert R.(2000). , Modelling species extinction: the case for non-consumptive values, *Ecological Economics,* 35(2): 259-269.

Wolf, Marianne McGarry. (2000). 'A Comparison of Consumer Attitudes toward Genetically Modified Food in Ireland and the United States: A Case Study over Time.' Paper presented at the International Conference of Agricultural Biotechnology Research. Ravello, Italy. June. 2000.

Wolfenbarger, L.L and P.R. Phifer (2000). The ecological Risks and Benefits of Genetically Engineered Plants, *Science*, v.290, p. 2088-2093

Yen, S.T and Jones, A.M. (1996). Individual cigarette consumption and addiction: a flexible limited dependent variable approach, *Health Economics*, 5, pp.105-117

Yen, Steven T and Jones, Andrew M. (1997). 'Household Consumption of Cheese: An Inverse Hyperbolic Sine Double-Hurdle Model with Dependent Errors', *American Journal of Agricultural Economics*, 79(1): 246-51.

Yen, Steven T. and Jensen, Helen H. and Wang, Qingbin (1996). 'Cholesterol Information and Egg Consumption in the US: A Non-normal and Heteroscedastic Double-Hurdle Model', *European Review of Agricultural Economics*, 23(3): 343-56.

Yen, Steven T.(1993). 'Working Wives and Food away from Home: The Box-Cox Double Hurdle Model', *American Journal of Agricultural Economics*, 75(4): 884-95.

Yen, Steven T., P., Boxall and W., Adamowicz (1995). 'An econometric Analysis of Donation for Environmental conservation' Staff Paper 95-05, Department of Rural Economy, University of Alberta

Yoo, Seung Hoon; Kwak, Seung-Jun and Kim, Tai Yoo (2000). 'Dealing with Zero Response Data from Contingent Valuation Surveys: Application of Least Absolute Deviations Estimator', *Applied Economics Letters*; 7(3): 181-84.

Zerbe, Richard O., Jr. (1991). 'Comment: Does Benefit-cost Analysis Stand Alone? Rights and Standing.' *Journal of Policy Analysis and Management* 10(1): 96-105.

Zerbe, Richard O., Jr. (1998). 'Is Cost-Benefit Analysis Legal? Three Rules.' *Journal of Policy Analysis and Management* 17(3): 419-456.

Zerbe, Richard O., Jr. (2001). Can Law and Economics Stand the Purchase of Moral Satisfaction?, Paper Presented at Symposium on Law and Economics, University College London Sep 5th, 2001

Zhi, Lu *et al.* (2000). 'What has the Panda Taught us', in Entwistle, A and Nigel Dunstone (Eds.). *Priorities for the Conservation of Mammalian Diversity: Has the Panda had its Day*, Cambridge, CUP, pp. 325-333.